GSC400 Series

Automatic Gen-Set Controller Manual

Revision 2.5

GSC400 ***Automatic Gen-Set Controller***
Installation and User Manual
Full Version File: GSC400 User Manual Rev2.5.doc, December 2009

Thank You For Purchasing This DynaGen Product

Please Read Manual Before Installing Unit

Receipt of Shipment and Warranty Return Information

Upon receipt of shipment, carefully remove the unit from the shipping container and thoroughly examine the unit for shipping damage. In case of damage, immediately contact the carrier and request that an inspection report be filed prior to contacting DynaGen.

All returned items are to be shipped prepaid and include a Return Material Authorization (RMA) number issued by DynaGen. RMA forms are available by contacting DynaGen Technical Support through the contact methods listed below.

Limited Warranty

The GSC400 Gen-set controller carries a five year warranty. For more information refer to the standard terms and conditions of sale at http://www.dynagen.ca.

Dynagen GSC400 Webpage

For up-to-date manuals and other information please see the GSC400 section of the Dynagen website at: **www.dynagen.ca/products/GSC400.htm**

We welcome your comments and suggestions. Please contact us at:

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GSC400 Specifications

VDC Rating	12/24 VDC		
Standby Current Consumption	50 mA @ 12 VDC		
Operating Temp	-40°C to +85°C (-40°F to +185°F)		
LCD Operating Temp***	-20^0C to 60^0C (-4^0F to $+140^0$F)		
Function Selection Range	Function	Selection	Range
	Speed Sensing	Generator pickup Magnetic pickup	0-300vac, 0-3600rpm 0-300vac, 0-3600rpm
	Voltage Sensing	Single phase, Three phase, Delta, Wye	Max 700vac, +/- 1% Max 700vac, +/- 1% Max 700vac, +/- 1%
	Current Sensing*	Enable/Disable	Max 5A, +/- 1%
	Frequency Sensing	Enable/Disable	1 – 100 HZ
	Engine Temp	GND=Fail, Open=Fail	10-265°F, 10-265°C
	Oil Pressure	GND=Fail, Open=Fail	0-90 PSI, 0-90 Kpa
	Oil Level	GND=Fail, Open=Fail	0-90%
	Fuel Level	GND=Fail, Open=Fail	0-100%
	Engine Logic	Delay to start Pre-heat Crank Rest Time Mid Heat Crank attempts False restart Post heat Warm-up Cooldown Crank oil pressure Crank Disconnect	0 – 60 seconds 0 – 60 seconds 3 – 60 seconds 1 – 60 seconds 0 – 60 seconds 1-60 tries Enable, Disabled 0 – 60 seconds 0 – 600 seconds 0-600 seconds 0-90 KPa 100-2000 RPM
	Analog Input	Input 2, 5-7 (High Z) Input 3-4 (Low Z)	Gnd=Fail, Open=fail 7mA Max
	Digital Input	Input A-D (Sw to Bat) Input E-H (Sw to Gnd)	Bat=Fail, 7mA Max Gnd=Fail, 7mA Max
	Digital Output	Output A-H Extra Relay	300 mA Max 40A Max
	Exerciser	Enable, Disable	10-240 Minutes
	Battery Recharge	Enable, Disable	10-240 Minutes
	Password	4-Digit	0-9
LCD Display	128x64 Graphic display, Backlit, 60° viewing angle, LCD operating temperature -30°C to +60°C (-22°F to +140°F)		
LED Display	Red, Green, Yellow LED representation, Daytime Visible, 60° viewing angle		
Programming	Manual, Software, Field upgradeable		
J1939 Interface	Low emission capable		
Relays**	Replaceable 40A relays for Crank, Fuel, Extra output. 12 or 24VDC Coil		
Dimensions	W x H x D, 139 x 113 x 65 mm (5.47 x 4.45 x 2.56 in.)		
Weight	0.45 Kg (1.0 Lb)		

*Use of Industry Standard CT Required. ** 40A output at room temperature. *** The LCD display will exhibit color and response time changes at high and low temperatures respectively but will not be damaged as long as within Operating Temp.

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1 GSC400 Controller Series

The GSC400 is designed for use on generator sets with either mechanical or electronic (J1939) engines. It can monitor analog data from senders on the engine and generator such as oil pressure, coolant temperature, current, voltage, and engine speed and generator frequency. The GSC400 can also gather engine parameters from the engine ECM via J1939 and use them to control the engine or for display purposes.

An RS232 interface is provided that allows communication with the DynaGen GSC400 PC Interface to change settings or display information on the PC. An RS485 port is provided for Modbus communications (slave only) for remote annunciation or communications.

In addition to the monitoring features, the GSC400 controller can be used to automatically start/stop a generator system as well as provide protective warnings or shutdowns.

GSC400 Front View

GSC400 Back View

1.1 This Manual

This manual is divided into three sections:

1. Hardware installation
2. Operation / configuration
3. Advanced configuration

2 Receiving, Handling, and Storage

Receiving:

Every effort is made to ensure that your GSC400 gen-set controller arrives at its destination undamaged and ready for installation. The packaging is designed to protect the GSC400 internal components as well as the enclosure. Care should be taken to protect the equipment from impact at all times. Do not remove the protective packaging until the equipment is at the installation site and ready to be installed.

When the GSC400 reaches its destination, the customer should inspect the shipping box and controller for any signs of damage that may have occurred during transportation. Any damage should be reported to a DynaGen representative after a thorough inspection has been completed.

A shipping label affixed to the shipping box includes a variety of product and shipping information, such as items and Customer numbers. Make certain that this information matches your order information.

Each GSC400 controller is packaged in its own box. Do not discard the packing material until the controller is ready for installation.

Handling:

As previously mentioned, each GSC400 gen-set controller is packaged in its own individual box. Protect the equipment from impact at all times and do not carelessly stack. Once the controller is at the installation site and ready to be installed, the packaging material may be removed.

Storage:

Although well packaged, this equipment is not suitable for outdoor storage. If the GSC400 is to be stored indoors for any period of time, it should be stored with its protective packaging in place. Protect the controller at all times from excessive moisture, dirty conditions, corrosive conditions, and other contaminants. It is strongly recommended that the package-protected equipment be stored in a climate-controlled environment of -20 to 65°C (-4 to 149°F), with a relative humidity of 80% or less. Do not stack other equipment on top of the stored controllers.

3 GSC400 Product Number Identification

The GSC400 series product numbering scheme (i.e. product number) provides various information – including options selected by the customer – about the unit. A product number has the format given in Figure 1.

The product number is located on the backside of the GSC400 controller under the bar code.

GSC400 - 0 - _ _ - _ _ _ - _ _ _ _ _

Position 1-6	Position 8	Position 10-11	Position 13-14	Position 15	Position 17 to 21
Series	Place Value	DC Voltage	Labeling	Revision	Identifier
Controller Series: GSC400	Set to 0.	12=12VDC 24=24VDC	LS=Standard LX=Customized	A letter is placed in this position to indicate the hardware revision level. No letter indicates revision A.	Uniquely indentifies the particular unit.

Figure 1 – GSC400 product numbering scheme

4 GSC400 Series Installation and Wiring

4.1 Safety Information

Generator systems contain high voltage circuits. Working on powered equipment can cause damage to equipment, injury, or death. The following symbols will be used in this document to classify information:

Caution: This is used to indicate something that you should take special notice of but that is not normally a threat to safety.

Danger: This is used to indicate a potential for injury or death.

Danger – High Voltage: This is similar to Danger above but releases specifically to conditions where high voltage is encountered.

The following general safety precautions should be headed:

1. The GSC400 may carry high Voltage/Current which can cause serious injury or death. Extreme caution must be exercised when connections are being installed to or from the controller. All wiring connections must be de-energized before any installations are performed. Wiring of the GSC400 should be performed by qualified electricians only.

2. AC power may carry high Voltage/Current which can cause serious injury or death. De-energize all AC power sources before any connections are performed.

3. **NEVER** energize AC power with AC current sensing connector unplugged. An energized, unplugged connector could result in severe injury or death. Never unplug an energized connector.

4.2 Mounting Location:

The GSC400 gen-set controller must be properly mounted for safe operation. Caution must be taken at the installation site to make sure the site is free from excessive moisture, fluctuating temperatures, dust, corrosive materials etc. The controller should be safely mounted in a secure location using the 3 mounting screws provided. See Figure 2 for the mounting locations.

Caution: Mounting screws must be installed at the recommended torque of 10 inch pounds.

Figure 2 – GSC400 Mounting Locations

4.2.1 GSC400 Mounting Dimensions

Figure 3 gives the precise dimensions of the mounting hardware.

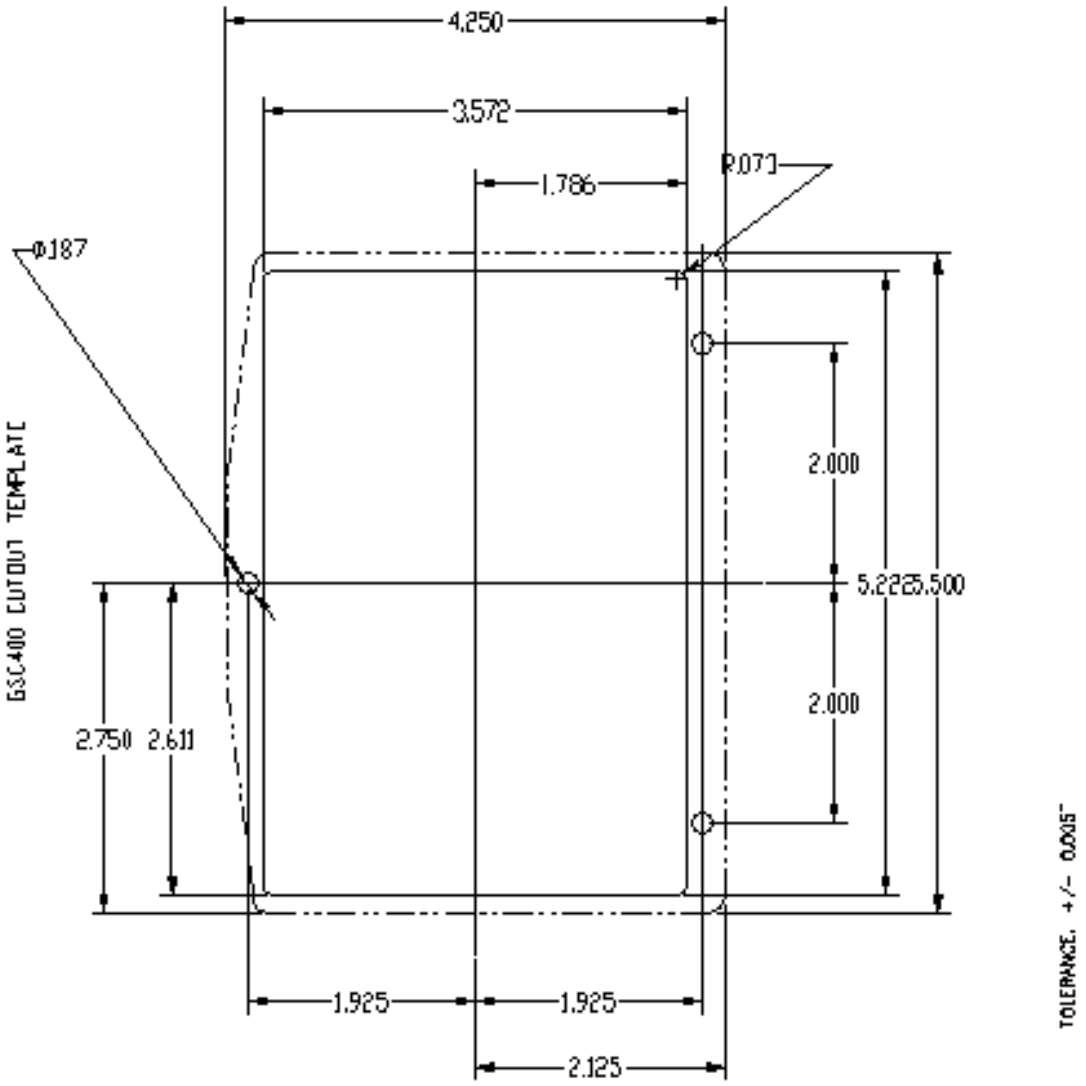


Figure 3 - Dimensions of mounting holes.

4.3 GSC400 12/24VDC System Operation

The GSC400 controller can be placed in either 12V or 24V electrical systems.

4.3.1 UL Rating

The GSC400 is UL listed to UL508. For conditions of acceptability refer to UL file number: E250327 or contact DynaGen.

4.3.2 40A Relays

The GSC400 controller is designed to operate on 12 or 24 VDC systems. When operating on 12VDC systems the fuel, crank and extra outputs require 12VDC relays, and 24VDC relays when operating on 24VDC systems. The GSC400 comes preinstalled with the correct relays depending on the product number specified when ordered (see section 3 on page 9).

Contact DynaGen if replacement relays are required (quote Dynagen Part numbers from Table 22 on page 76).

UL Listed relays for 12 or 24VDC system operation are as follows:

- HASCO CAR-1A-40-DC12-S for 12VDC operation
- HASCO CAR-1A-40-DC24-S for 24VDC operation

CAUTION: The above relays must be installed in the GSC400 for it to meet UL.

4.3.3 Relay Fuses

CAUTION needs to be taken when connecting relay outputs to an inductive load. Due to the inductive nature of certain loads (starters, pull coils), initial current draw may be higher than stated in the load specs which could damage the onboard relays.

Output relays are protected by onboard 40A fuse protection. Smaller amperage fuses from many automotive stores may be used in place of the higher current 40A. If installing lower amperage fuse protection, be certain that the current draw on each relay does not exceed the fuse current limit.

An approved 40A fuse is:

- LITTLEFUSE – 257040 (32VDC, 40A, auto fast action)

4.4 GSC400 Terminals

The type and part number for each of the terminal connections are given in Table 1 . Figure 4 on the next page shows the location of all terminals on the controller and the numbering of all circuits. Table 17 on page 74 gives the part numbers of the various starter-kit harnesses you can order from DynaGen. Only commonly used circuits on each connector are populated (i.e. connected with a wire on the harness). Table 17 also lists the circuits (i.e. pins) that are included as part of the harness.

Table 2 lists the minimum wire size, maximum current capacity, name, and function of each circuit. **The wire gages given in the table are the minimum recommended only.** To maintain UL rating, the correct wire gauge as specified by UL must be used.

Table 1 – GSC400 Terminal Information (Manufacturer and Part Number)

Terminal Name	GSC400 Terminal Type	Mating Connector Type (For Wiring Harness)
Digital Inputs	Molex 39-28-1123	Molex 39-01-2120
Digital Outputs	Molex 39-28-1103	Molex 39-01-2100
AC Current	Molex 39-28-1063	Molex 39-01-2060
RS485 (Modbus)	Molex 39-28-1063	Molex 39-01-2060
CAN (J1939)	Molex 39-28-1043	Molex 39-01-2040
Analog Inputs	Molex 39-28-1083	Molex 39-01-2080
RS232	Amp 87227-5	Major League Electronics TSHS-1-05-D-16-A-C (2x5pin double header, 0.1” spacing)
Quick Connects (Spade Terminals)	Keystone 4901 (0.25” wide)	Standard 0.25” wide female quick connect
The Molex connectors above require the following contacts: **Molex 39-00-0039**. The hand crimp tool required to crimp the contacts to the wire is **Molex 0638190900**. The extraction tool part number is **Molex 011030044** which allows you to remove contacts from the Molex connector without damaging the contact. The extraction tool is available from DynaGen (part number: **ACC0097**).		

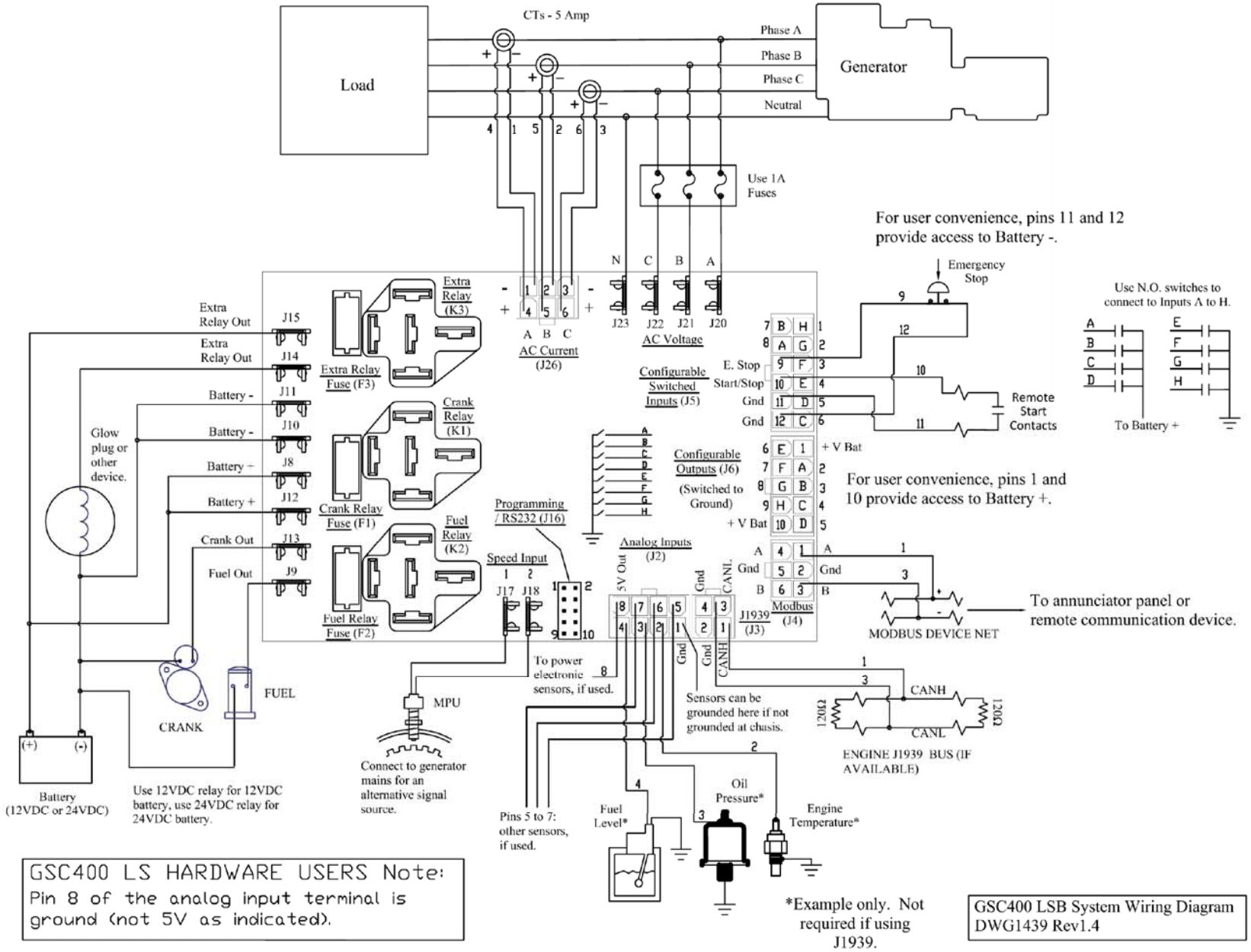


Figure 4 – General GSC400 System Wiring Diagram

Table 2 – GSC400 Terminal Details

Quick Fit Terminals	**Terminal**	**Wire Size (AWG)**	**Current max.***	**Function**	
	Crank	12	40A	Crank Output Terminal	
	Battery +	12	40A	Positive Battery Terminal	
	Battery -	12	40A	Negative Battery Terminal	
	Fuel	12	40A	Fuel Output Terminal	
	Extra Relay[1]	12	40A	Configurable[1] Dry Contact[2]	
	Extra Relay	Other side of Configurable Dry Contact[2]			
	Speed 1	18	100mA	Speed Signal Connection	
	Speed 2	18	100mA	Speed Signal Connection	
	*Total controller current output (max 60A) [1] This is a configurable output. See Table 13 on page 59 for possible selections. [2]A normally open SPST relay with user access to both sides of the switch. This is unlike the Fuel and Crank relay outputs which have one side connected internally with battery positive and the opposite side accessible to the user.				
Analog Inputs	**Terminal Detail**	**Terminal Location**	**Wire Size (AWG)**	**Current max.**	**Function**
	Ground	1	18	7mA	Ground
	Input 2	2	18	7mA	Configurable (Low Resistance, Gain of 1) *
	Input 3	3	18	7mA	Configurable (Low Resistance, Gain of 3)
	Input 4	4	18	7mA	Configurable (Low Resistance, Gain of 3)
	Input 5	5	18	7mA	Configurable (High Resistance, Gain of 3)
	Input 6	6	18	7mA	Configurable (High Resistance, Gain of 1) **
	Input 7	7	18	7mA	Configurable (High Resistance, Gain of 3)
	5V out ***	8	18	7mA	Power for electronic sensors. ***
	* Revision B hardware only. For revision A hardware, this input spec is High Resistance, Gain of 3. ** Revision B hardware only. For revision A hardware this input has a gain of 3. *** Revision B hardware only. For revision A hardware this terminal is a ground.				

Digital Inputs	Terminal Detail	Terminal Location	Wire Size (AWG)	Current max.	Function
	Input H - GND	1	18	7mA	Configurable[1]
	Input G - GND	2	18	7mA	Configurable[1]
	Input F - GND	3	18	7mA	Configurable[1]
	Input E - GND	4	18	7mA	Configurable[1]
	Input D - BAT	5	18	7mA	Configurable[2]
	Input C - BAT	6	18	7mA	Configurable[2]
	Input B - BAT	7	18	7mA	Configurable[2]
	Input A - BAT	8	18	7mA	Configurable[2]
	Emer. Stop	9	18	7mA	Allows Manual Emergency Stop (Open = Active)
	Start/Stop	10	18	7mA	Allows Manual Start/Stop of Engine (Active = Start, Inactive = Stop)
	Ground	11	18	7mA	Ground
	Ground	12	18	7mA	Ground
	[1] Ground input to generate logic high. [2] Tie input to battery + to generate logic high.				

Digital Outputs*	Terminal Detail	Terminal Location	Wire Size (AWG)	Current max.	Function
	+ V Bat	1	18	1.5A	Positive Battery Voltage
	Output A	2	18	200mA	Configurable*
	Output B	3	18	200mA	Configurable*
	Output C	4	18	200mA	Configurable*
	Output D	5	18	200mA	Configurable*
	Output E	6	18	200mA	Configurable*
	Output F	7	18	200mA	Configurable*
	Output G	8	18	200mA	Configurable*
	Output H	9	18	200mA	Configurable*
	+ V Bat	10	18	1.5A	Positive Battery Voltage
	*See Table 13 on page 59 for possible selections. **These are sinking outputs (i.e. switched to ground).**				

RS485 (Modbus)	Terminal Detail	Terminal Location	Wire Size (AWG)	Current max.	Function
	RS485-A	1	18	7mA	RS485 Connection High
	Ground	2	18	7mA	Ground Terminal Connection
	RS485-B	3	18	7mA	RS485 Connection Low
	RS485-A	4	18	7mA	RS485 Connection High
	Ground	5	18	7mA	Ground Terminal Connection
	RS485-B	6	18	7mA	RS485 Connection Low
	For safety, it is highly recommended to install a switch on either the RS485 A or B lines locally at the generator. This can be used to prevent an unexpected start remotely while performing maintenance or repairs.				

AC Voltage Sensing	Terminal	Wire Size (AWG)	Current max.	Function
	Phase A*	18	7mA	Monitor Generated AC Voltage
	Phase B*	18	7mA	Monitor Generated AC Voltage
	Phase C*	18	7mA	Monitor Generated AC Voltage
	Neutral	18	7mA	AC Voltage Neutral connection
	*Place 1A fuse between the hot lines and the voltage sensing terminals of GSC400.			

AC Current Sensing	Terminal Detail	Terminal Location	Wire Size (AWG)	Current max.	Function
	Phase A	1	18	5A	Phase A current sensing CT-
	Phase B	2	18	5A	Phase B current sensing CT-
	Phase C	3	18	5A	Phase C current sensing CT-
	Phase A	4	18	5A	Phase A current sensing CT+
	Phase B	5	18	5A	Phase B current sensing CT+
	Phase C	6	18	5A	Phase C current sensing CT+
	It is extremely important to connect each phase to the appropriate terminal location. Never mix phase inputs. Always match terminal details to the matching terminal location. The current transformers (CTs) negative leads must be terminated individually into the GSC400 AC Current connector.				

J1939 (CAN)	Terminal Detail	Terminal Location	Wire Size (AWG)	Current max.	Function
	CANH	1	18	7mA	CANH Connection
	Ground	2	18	7mA	Ground Terminal Connection
	CANL	3	18	7mA	CANL Connection
	Ground	4	18	7mA	Ground Terminal Connection
	Important! 120Ohm resistors must be placed on either end of the bus.				

4.4.1 CAN Wiring Note (J1939)

The CAN communication bus's CANL and CANH lines must be terminated with 120Ohm resistors on either end of the bus. If you are not connecting to an existing bus you must do this. If you are connecting to an existing bus check that it has the proper terminating resistors.

To check for proper resistance disconnect the CAN bus harness from the GSC400 and measure across the CANH and CANL pins on the harness connector. It should be 60 Ohms (two 120 Ohms in parallel). If you measure 120Ohms then only one resistor has been installed.

If using the optional J1939 harness DWG1373R3-5 from Dynagen there is a 120Ohm resistor built in. It can be cut out if the GSC400 is not the last device on the bus. If you are using DWG1375R2-5 this version of the J1939 harness does not have a terminating resistor.

4.4.2 Current Transformer (CT) Wiring Note

The current transformers (CTs) negative leads must be terminated individually into the GSC400 AC Current connector. **Do not tie the negative leads together to a common neutral or ground.** The negative lead of the CT is usually black.

5 GSC400 Operation and Basic User Configuration

5.1 Power-up

The very first time the controller is powered up the unit will go through an initialization where all the configurable settings are set to factory default values. This will happen only on the first power-up. Once the initialization is finished, the controller will display the firmware and hardware version on the screen and flash the indicator lamps on the side of the controller (this will also occur during all subsequent power-ups).

The controller will then enter the OFF mode. By default, it is possible to manually start the generator in the OFF Mode. The user can disable manual start in OFF mode in the basic menu (in which case the GSC400 must be in the AUTO mode to manually start the generator). See section 5.9.2 on page 28.

Pressing the Auto key will cause the controller to enter the AUTO mode. From this mode, the user can manually put the controller into RUN mode (i.e. start the generator) or the controller itself will be able to start the generator automatically if required (e.g. remote start capability on low battery if enabled).

The controller has the ability to remember whether it was in the OFF or AUTO mode the last time it was powered up and will reenter that mode when it is repowered.

5.1.1 Controller Alarming

If the **emergency stop input** of the digital input terminal is not connected to ground the controller will alarm and display “Emergency Stop” when connected. Emergency Stop also forces the controller to the OFF mode. To prevent this ground the emergency stop input (pin 9) to either of the grounds (pins 11 or 12) on the digital input terminal. See Figure 4 on page 15.

5.2 Remote Start Contacts / Emergency Stop

The GSC400 has a dedicated **remote start contact** located on the digital input connector. See Figure 4 on page 15 for the location of the remote start contact. A grounded signal on the contact when the controller is in AUTO Mode (see below for more information on the AUTO Mode) will cause the controller to start. Removing the ground will cause the controller to go back into AUTO Mode.

It is also possible to set one of the programmable digital inputs as a remote start contact. This feature works the same way as the dedicated remote start (active = start). See Table 14 on page 62 for more information on the digital input features.

The GSC400 also has a dedicated **emergency stop** input that when open will stop the generator immediately and the controller will enter the OFF Mode (see below for more information on the OFF Mode) and remain in the OFF Mode until the emergency stop input is grounded. While the emergency stop input is active the GSC400 will sound an audible alarm and display "Emergency Stop" on the LCD display. See Figure 4 on page 15 for the location of the emergency stop input.

5.3 Controller States

The GSC400 incorporates 3 primary modes of operation:

1. OFF Mode
2. AUTO Mode
3. RUN Mode

1. OFF Mode – When the GSC400 is set to the Off Mode, automatic starting will be disabled. No automatic controls will be initiated. The Off Mode may be initiated when no generator controls are required or when the controller configuration requires adjustment. The user can disable manual start in OFF mode in the basic menu. See section 5.9.2.

All of the failures and most of the warnings are disabled when the controller is in Off Mode. The controller will beep every few seconds to alert the user that the unit is in the Off Mode and cannot automatically start. To silence this alarm press the off key as instructed on the screen.

In Off Mode you may simultaneously press the up and down arrow keys to perform a lamp test.

2. AUTO Mode - When the GSC400 is set to the Auto Mode, automatic starting will be enabled. Possible triggers include start/stop, battery recharge and exerciser features (all of which are controllable from the menu system). If the engine is started, failures will be automatically detected allowing for safe engine operation.

While in Auto Mode the controller will display engine temperature, battery voltage, fuel level, and engine hours.

3. RUN Mode – The controller starts the engine/generator and enters the RUN Mode automatically on certain triggers (low battery voltage or to exercise the generator) or the user can manually start the engine/generator by pressing the Run key. Another option is to use the remote start contacts located on the digital input connector. The controller will automatically shut the engine/generator down and re-enter the auto mode if it initiated an engine/generator start. When the controller is in the OFF Mode automatic starting is disabled.

When the controller is in the RUN Mode, generator parameters will be displayed on the screen to allow the user to monitor the engine status. These include engine speed, generator voltage and current, and engine temperature as well as others. The parameters are displayed in groups and the screen scrolls between the various groups. The **Page Roll Display** menu option controls how long each parameter group is displayed on the screen before moving on to the next group. See Table 5 on page 29 for more information.

If an analog input is set to a **Switch** the GSC400 will display “SW” where normally the value is displayed. If the analog input is set to J1939 or an Input Pin then the actual value of the input will be displayed.

5.3.1 Locking the GSC400 Screen While in the Run Mode

When in the RUN Mode the GSC400 LCD screen can be locked to display a particular parameter group. To do this press the up or down keys to scroll to the parameter group you wish to view and then press the ENTER key to lock the screen. You will see a lock symbol displayed on the top right hand side of the display just under the date and time.

To unlock the screen press “Enter” again which causes the lock symbol to disappear and the screen will start to scroll though the parameter groups again. The screen will automatically unlock after 10 minutes.

5.4 GSC400 Start / Stop Behavior

There are three ways to start the generator (start conditions):

1. Modbus – Sending a "Start" using the appropriate register.
2. Remote Start Contacts – Pins 10 and 11 of the digital input connector.
3. Run key – Located on the GSC400 front panel.

There are two features that can automatically start the generator:

1. Battery Recharge
2. Exerciser

The battery recharge and exerciser options will only start the generator when the GSC400 is in the AUTO mode. These features will not interrupt a shutdown.

When the controller is in the AUTO mode the three manual start conditions above can be used to start the generator. When the controller is in the RUN mode it will display the reason for start on the screen (Modbus Run, Remote Start Run, Manual Run, …).

Stopping the Generator

If the controller is in the RUN mode due the remote contacts or modbus, for the first 10s either of the two can be used to place the controller back in the OFF state (the remote start contacts cannot be used to stop the generator unless it was the cause of start). After this 10s period only the start condition that caused the start can be used to place the controller back in the AUTO or OFF mode. The OFF key can be used to place the GSC400 in OFF regardless of the start condition.

Preventing a Stop when in Cool Down

An exception to the above is that once the GSC400 is in cool down and another start condition was received the controller will exit cool down and remain running. It will display the new start condition on the screen.

OFF key pressed during Manual Run

If the OFF key is pressed during a manual Run, a cool down popup will display on the GSC400. Press the AUTO key to immediately enter the Auto mode, press the OFF key to immediately enter the Off mode, or press the Enter key to enter cool down. If no key is pressed the GSC400 will remain in the Run mode.

If the OFF key is pressed during another start condition (e.g. Modbus Run) a cool down popup will appear again but in this case the only option is to press the OFF key to immediately enter the OFF mode.

5.5 Idle Mode

For generators that have the capability of idling at a lower speed than the normal operating speed the GSC400 controller has an **Idle Mode** feature that suppresses the warnings and failures for under-voltage, under-frequency, and under-speed. The GSC400 displays "**Idle Running**" when this feature is enabled.

The controller remains in Idle Mode as long as the **"Idle Mode" digital input** is active. See Table 14 on page 62 for more information on the digital inputs. If the user desires a digital output to turn on during Idle Mode, the "Voltage Regulator" digital output can be used. It is active when the controller is in Idle Mode and inactive when the controller is not in Idle Mode. See Table 13 on page 59 for more information on the digital outputs. The output is usually used to turn off the generator voltage regulator but can be used for any purpose.

For users who have engines that idle during warm-up and/or cool-down (See section 6.5 on page 57 for more information on the Warm-up and Cool-down features.) the "**Warm-up**" and "**Cool-down**" digital outputs can be tied to the "Idle Mode" digital input.

5.5.1 Cummins Electronic Engine Idle Mode

For Cummins electronic engines the GSC400 will control the engine using the J1939 speed control feature. Whenever the Idle Mode digital input is active the GSC400 will send a command over J1939 to put the engine into idle. See section 5.12.1 of page 35 for more information. To program this feature using the GSC400 front panel menu see section. 6.1.1 on page 48.

5.6 Generator Starting and Stopping

The GSC400 startup and shutdown behavior can be set by the user from the Advanced menu (password protected) such as the amount of time to wait before starting, whether to preheat and for how long, the crank time, etc. See sections 6.5.1 Startup Sequence and 6.5.2 Shutdown Sequence starting on page 57 for more information on the options for starting and stopping the generator respectively.

5.7 Controller Sleep

The controller has a low power Sleep Mode that it can enter when in the OFF or AUTO states. In this state the LCD screen backlighting is turned off. The time it takes to enter Sleep Mode is configurable in the menu. It is recommended that the Sleep Delay is set as short as possible to prolong the life of the backlighting and to reduce battery consumption.

The backlight display will illuminate automatically when a key is pressed. A key press will only cause the controller to exit the Sleep Mode. The key must be pressed again to perform its normal function.

5.8 GSC400 Menu System Operation

The GSC400 incorporates a menu system to allow the end user to adjust basic settings. The menu system will also allow technicians and OEMs to adjust advanced settings (this feature is password protected).

With the controller in the Off Mode, the menu system may be selected simply by pressing the Enter key.

In the off state press “ENTER” to access the GSC400 Menu System. This is called the Basic Menu. The following keys perform the menu navigation:

1. Scroll up using the up key
2. Scroll down using the down key
3. Enter menus by pressing the enter key.

Each menu has a “Back” selection. To go back to the previous menu scroll up to the Back selection and press the Enter key. When in the basic menu you can go back to the OFF mode by pressing the OFF key.

5.9 Basic Menu

When you press the Enter key in the OFF mode you will enter the basic menu which includes the Clock Setup, Basic Setup, Advanced Setup, and Failure History submenus.

1. Clock Setup
2. Basic Setup
3. Advanced Setup
4. Failure History

Table 3 - Basic Menu Layout		
Basic Menu	Clock Setup	Year Month Date Day Hour Minute 12/24
	Basic Setup	Contrast Adj. Page Roll Delay State Roll Dly Sleep Delay Maintenance Not In Auto Off Mode Start
	Events History	

5.9.1 Clock Setup

The Clock Setup menu will allow you to set the clock. The clock is important if you are planning to use the event log (records all failures and warnings and when they occurred) or the exerciser feature (starts the generator for a settable period).

Table 4 – Clock Setup Menu

Menu	SELECTION AND RANGE
Year	2000 - 2099
Month	January - December
Date	01-31
Day	Monday - Sunday
Hour	00-23
Minute	00-59
12/24	12 Hours, 24 Hours

The GSC400 internal clock information can remain “in memory” for approximately 2 weeks when no DC power is supplied to the controller. Two week memory storage is available in a completely charged controller clock. DC power is required to be supplied continually to the GSC400 for approximately 1 hour to allow a complete clock charge.

5.9.2 Basic Setup

The Basic Setup menu will allow the user to customize the basic features of the GSC400 to their preference.

The **Contrast Adjustment** allows the user to adjust the contrast of the LCD.

The **Page Roll Delay** controls how long each group of parameters are displayed in the RUN state (i.e. when the engine/generator is running) before displaying the next set of parameters.

The second line of the GSC400 LCD screen is usually dedicated to displaying warnings, and events. The **State Roll Delay** determines how long the warning or event message is displayed before moving on to the next message**. Setting the State Roll Delay to a larger value may cause some warning or event messages to not be displayed if the event or warning is of a short duration.**

The **Sleep Delay** determines how long to wait after the last key press before turning off the LCD backlighting. The Sleep Delay also controls the automatic exit from the menu system. First the controller exits to the basic menu after the first sleep delay, exits to the Off state after the second sleep delay, and finally goes into sleep mode after the third sleep delay. The sleep delay does not work in the Run Mode or during cranking.

The controller can be made to NOT sound the alarm when the controller is not in the AUTO mode. This is controlled by the **Not In Auto** setting.

The **OFF Mode Start** setting can be set to Enable to allow a manual start from the OFF mode. Otherwise a manual run can only be performed when the controller is in the AUTO mode.

Table 5 – Basic Setup Menu

Menu	SELECTION AND RANGE
Contrast Adjust	5-95 %
Page Roll Delay	1-10 s
State Roll Delay	1-10 (1 is shortest delay, 10 is longest)
Sleep Delay	10-600s. Shorter is ideal to extend the backlighting life.
Maintenance	Read only. Displays the amount of hours until next service if this feature is enabled. If service is overdue the hours become negative.
Not In Auto	Disable Beep, Enable Beep
OFF Mode Start	Disable, Enable

5.9.3 Event History Log

The GSC400 incorporates an event history logging system. When engine failures, events, or DTCs (Diagnostic Trouble Codes – see section 5.13 on page 36) occur, an entry is created in the GSC400 Event History Log.

A total of 100 entries can be recorded. Entries may be viewed simply by scrolling up or down using the "UP" and "DOWN" keys. In addition to the entry reason information, the associated date and time of the entry will be displayed.

The 100 entries are subdivided into a maximum of 30 events, 40 failures, and 30 DTCs. This prevents one type from flushing the other types from the log.

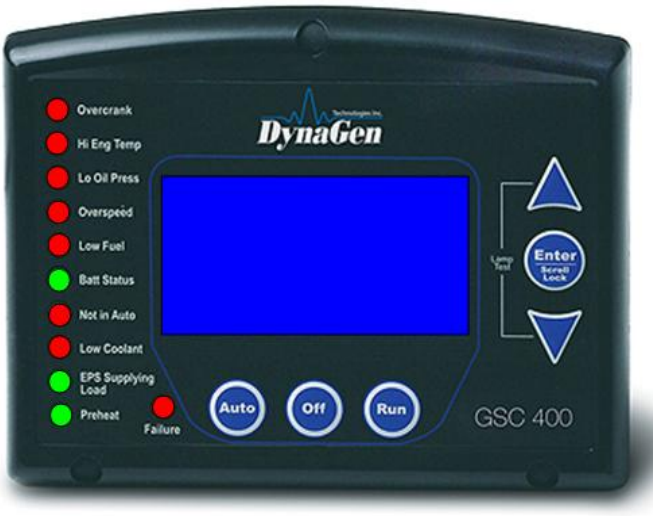
Simply scroll through the Failure History Log by pressing the ▼ or ▲ keys located on the GSC400.

The event history log can store up to 30 event, 30 DTCs, and 40 failures entries. If these are exceeded the entry is replaced with the newest entry. The events, failures, and DTC entries are displayed together in the log in reverse chronological order (i.e. newest entry first).

Upgrading the controller firmware to revision 1.50 from an earlier revision will cause the history log to be reset.

5.10 GSC400 LED Status Indicators

Some industry standard failures, warnings, and events on the GSC400 are indicated by a series of LEDs on the left side of the controller.



Specific LED indicators will be illuminated depending upon the condition of the controller. The GSC400 LED indicators allow a quick check of the controller's condition.

The GSC400 displays multi color LED's for specific condition representation.

Red
- Represents Failure Conditions

Yellow
- Represents Warning Conditions

Green
- Represents Normal/Active Conditions

An LED test may be performed by the user for illumination of all controller LED's. The LED test may be performed by simultaneously pressing the UP key and the DOWN key the GSC400.

Table 6 – GSC400 Lamp Indication Meanings			
LED Description	**LED Color**	**LED Status**	**Indication**
Over Crank	Red	Solid Red	A solid red illuminated LED represents an Over Crank condition on the final crank attempt. This is a Failure.
	Yellow	Solid Yellow	A solid yellow illuminated LED represents an Over Crank Warning condition when there are crank attempts still remaining.
High Eng Temp	Red	Solid Red	A solid red illuminated LED represents a High engine Temp Failure condition.
	Yellow	Solid Yellow	A solid yellow illuminated LED represents a High engine Temp Warning condition.
Low Oil Press	Red	Solid Red	A solid red illuminated LED represents a Low Oil Pressure Failure condition.
	Yellow	Solid Yellow	A solid yellow illuminated LED represents a Low Oil Pressure Warning condition.
Over Speed	Red	Solid Red	A solid red illuminated LED represents an Over Speed Failure condition.
	Yellow	Solid Yellow	A solid yellow illuminated LED represents an Over Speed Warning condition.
Low fuel	Red	Solid Red	A solid red illuminated LED represents a Low Fuel Level Failure condition.
	Yellow	Solid Yellow	A solid yellow illuminated LED represents a Low Fuel Level Warning condition.
Battery Status	Green	Solid Green	A solid green illuminated LED represents a normal battery condition.
		Flashing Green	Controller in Auto mode – Waiting to start
	Yellow	Solid Yellow	A solid yellow illuminated LED represents a Low Battery condition.

LED Description	LED Color	LED Status	Indication
Not In Auto	Red	Solid Red	A solid red illuminated LED represents a Not in Auto condition.
Low Coolant	Red	Solid Red	A solid red illuminated LED represents a Low Coolant (Temperature and/or Level) failure condition.
	Amber	Solid Amber	A solid yellow illuminated LED represents a Low Coolant Temperature Warning condition
Pre-Heat	Green	Solid Green	A solid green illuminated LED represents an active Pre-Heat condition.
EPS Supplying Load	Green	Solid Green	A solid green illuminated LED indicates that the generator is supplying load and is operating normally.
	Red	Solid Red	A solid red indicates load is detected on the generator when none should be. See section 5.11.2 on page 35 for more information about EPS Supplying Load.
Failure	Red	Solid Red	A solid red illuminated LED represents a general Failure condition.

5.11 Warnings and Failures

The GSC400 incorporates many types of warnings and failures. Some are only active in the RUN mode while others are also active in the AUTO and/or OFF modes. Warnings and failures can be triggered from a Digital Input, Analog Input, AC Voltage, AC Current, Speed Signal Input, as well as others. The Advanced Setup section of this manual will give more information of the specific warning and failures for each type of input.

When a warning occurs, the second line (the area under the time and date display) of the LCD is used to display the warning text. Also, after the warning is displayed, instructions are displayed showing the user how to silence the warning. When in the AUTO or RUN modes the instructions are to press the Auto key and when in the OFF mode press the Off key.

When a failure occurs (although most failures only occur in the RUN mode, the Low Fuel Level and Low Coolant Level failures occur in any state including OFF and AUTO) the controller exits the RUN mode and goes to the FAILURE mode – turning off the Fuel output and other outputs on or off depending on the advanced settings – and displays the failure message. The alarm will sound and remain on until it is silenced by the user. The Auto key can be pressed to silence the alarm. Once the alarm is silenced it can be reset by pressing the Auto key and then the Off key. This returns the controller to the OFF mode.

The failure is recorded in the event log accessible from the Basic menu.

5.11.1 Diagnostic Trouble Code Shutdowns

This section only applies if the Diagnostic Trouble Code (DTC) feature is enabled. See section 5.13 for more information on DTCs.

The GSC400 does not have the ability to detect when the generator ECM has shutdown the generator. In the case of an ECM shutdown the GSC400 will display one of the following failures reasons:

1. Low Oil Pressure
2. Under Speed
3. Under Frequency
4. Under Voltage

The failure message display will depend on the user's failure set points for the above. On one of the above failures the user can check the Event History Log (see section 5.9.3 on page 30 about the history log) to determine if there has been a shutdown of the generator due to a DTC (DM1).

5.11.2 EPS Supplying Load

The GSC400 is often used to control a utility backup generator. When the generator is started and load is detected on the generator when the GSC400 is in the RUN mode the "EPS Supplying Load" LED on the GSC400 front panel will turn green. This indicates that the generator is supply load as normal. If load is detected on the generator when it is not in the Run mode (e.g. the GSC400 is cranking, preheating, etc) the GSC400 terminates starting and enters the failure mode and the "EPS Supplying Load" LED on the GSC400 front panel will turn red.

The generator is considered loaded when either the AC current is equal to or greater than 5% of the over current failure setpoint or if the EPS Supplying Load Switched Input is active.

5.12 J1939

This section applies if J1939 is enabled for one or more parameters. The parameters will be displayed the same for J1939 as they are for analog inputs. The only difference is that when a certain parameter is not read from the J1939 bus the text "N.A." is displayed in place of the parameter value.

If the Loss of ECM setting is enabled the GSC400 will shut the generator down on "Loss of ECM" if no communications are detected on the J1939 bus.

5.12.1 Cummins Idle Speed Control

For generators using Cummins electronic engines the GSC400 has the capability of switching between Idle speed and operating speed (i.e. the speed at which the generator produces load) if enabled. This feature is activated by applying a signal to one of the GSC400 digital inputs (see section 6.1.1 on page 48 for more information on how to setup this feature).

5.13 J1939 Diagnostic Trouble Code (DTC) Display

This section applies for electronic generators only (i.e. generators that use J1939)

The GSC400 can read J1939 diagnostic trouble codes (DTCs) from an electronic ECM, if enabled (see section 6.1.2 on page 49 for information on how to configure and customize the GSC400 DTC feature).

5.13.1 DM1 Messages

When the engine's ECM detects a fault, it will send an Active Diagnostic Trouble Code, DM1, message. The DM1 message sent by the ECU will also contain information on the type of fault as well as the number of occurrences for the fault. If multiple DTCs are present, each will be transmitted over the J1939 network. When the DM1 messages are received by the GSC400 controller there are 3 important pieces of information that are captured and displayed:

FMI Failure Mode Indicator - The type of failure. You must refer to the engine manufacturer's documentation to identify the meaning of the failure mode indicator number.

OC Occurrence Count - Identifies the number of times the failure has occurred.

SPN Suspect Parameter Number - The parameter number.

If one of these DTCs appears, please consult your engine manufacture for the definition of this fault. With some engine manufacturers, the text of the message can also vary slightly between engine types.

When active DTC messages are being received this will cause the controller display to lock and display the messages. If multiple active DTCs are received the controller will scroll and display each DTC message. The time between scrolling will be 3 seconds. The DTC message display will look at follows.

Figure 5 – Single Active DTC message

Figure 6 – Five active DTC messages and the 3rd one being displayed

The user can also manually cycle through the DTC messages by activating either the "UP" or "DOWN" key after the screen has been locked. If the user stops at a specific DTC message the display screen will remain on that message for a period of 10 seconds before it begins scrolling again. Once the last DTC message is displayed, the display will begin scrolling though other GSC400 parameters as normal. The DTC messages are no longer available for viewing.

5.13.2 DM2 Messages

DM2 messages are previously active faults messages which are stored to permanent memory on the engine ECM. These stored messages can be retrieved by the host GSC400 controller and displayed on the controller when a request is initiated by the user. The DM2 messages display the same type of information as the DM1 messages.

The GSC400 controller can support a maximum of 32 messages. When previously active DTC messages are requested and received, the GSC400 controller will display the stored messages on the GSC400 front panel LCD screen. If multiple stored messages are received the user can either manually scroll through each stored message or the screen will scroll between each DTC stored message at a 3 second interval. If the user intervenes, the interval will change to 10s. The DTC stored message display appears as follows:

Figure 7 – 32 stored DTC messages, the 5th stored code being displayed

To Trigger a DM2 Request, simultaneously press the "UP" and "DOWN" keys for a period of 3 seconds in either the AUTO, OFF, or RUNNING modes. The controller's alarm will sound and the controller will send a request to the ECM. A LAMP test will additionally be triggered in the OFF mode. The "UP" and "DOWN" keys can also be pressed to remove the DM2 message screen.

If the GSC400 is in the OFF or AUTO mode when the request is triggered, the ECM may not be powered on, so the controller will energize the fuel relay output and wait for the ECM to power on. The GSC400 then sends out the DM2 request. In the event there is no response from the ECM, the controller will re-attempt sending out the DM2 request an additional 3 times every 1.25 seconds. It will then display "REQUESTING FAIL" and turn off the fuel output if there is no valid response on the fourth try. The default ECM address for DM2 request is 0 and the ECM address can only be changed from the GSC400 PC interface. The GSC400 may also show "READING ABORT..." if communication is unsuccessful. If the request was successful, the GSC400 will show "READ DTC SUCCESS" and start to display the messages.

5.13.3 DM1 Event Log:

The GSC400 Event Log (see section 5.9.3 on page 30) can store up to 30 DM1 messages (DM2 messages are not stored). Once the 30 limit has been reached the oldest message is removed from the log to be replaced by the incoming DM1. All entries in the log are stored in a reverse chronological order with the most recent event display first.

6 Advanced Setup

Important!

After changing any settings on the controller, the controller needs to be reset. This can be done one of two ways:

1. Power off, wait for 2s, and power on the controller.
2. Press the Run key, wait until the controller begins the start sequence and then press the OFF key. You will see a flickering of the screen as the controller updates.

The GSC400 incorporates an Advanced Setup menu. Menu adjustments include input, output and other advanced settings. The possible advanced menu selections are covered in this section. Only OEMs or advanced and knowledgeable users should change these parameters.

Before entering the Advanced menu a password is required to be entered. The password will consist of a four digit number. Each number needs to be selected using the up or down arrows on the GSC400. Simply choose the correct password number for each selected position by scrolling to the proper number followed by the Enter key.

The default password is 0 0 0 0. The password may be changed anytime. See Password Setup section.

The Advanced Setup menu on the GSC400 is shown to the right.

Table 7 – Advanced Menu Layout Summary		
Menu Layout		**Description**
Advanced Menu (Password Protected)	J1939 Setup	The J1939 setup contains general settings for J1939 such as shutdown on loss of messages. To read parameters from the J1939 bus please see "Analog Inputs" below.
	High Engine Temp	**Analog Inputs**: These control all aspects of the specific analog input listed in the left column such as whether it is a switch, sender, or obtained from J1939. You can also set the input you want it to connect to. The warnings and failures as well as open and shorted sender detection shutdowns are also configurable.
	Oil Pressure	
	Fuel Level	
	Oil Level	
	Fuel In Basin	
	Low Engine Tmp	
	Speed Sensing	The speed sensing source (magnetic pickup, generator voltage, J1939), under and over speed warnings and failures.
	AC Frequency	The crank disconnect frequency and the over/under frequency warning/failures.
	AC Voltage	The AC voltage sensing/display is contained here as well as the over and under voltage warnings and failures.
	AC Current	The CT ratio, AC current sensing and display enable are contained in this menu.
	Engine Logic	All the basic start and shutdown logic are contained in this menu.
	Outputs Setup	This menu allows you to assign a feature/action to one of eight digital outputs. For example you can turn on a digital output when an under-speed failure occurs.
	Exerciser Set	Generators require periodic operation as part of their scheduled maintenance. This menu allows settings to control how often the engine/generator is started and for how long.
	Inputs Setup	This menu allows you to assign features/warnings, for example low oil pressure, to one of eight digital inputs.
	Battery Setup	This menu controls the settings for the battery under and over voltage warnings and failures. It also allows the user to set at what battery voltage to start the

		generator and how long the generator is to remain running.
	Set Password	The advanced menu requires a password for access. The user can change the password here. The default password is 0000.
	Set Maintain	This menu controls the service notification feature for regular maintenance. The user can enable/disable the feature and set the service interval. A technician can reset the service interval here. On reset the service counts down to the next service.
	Set Modbus	This sets the modbus slave address and baud rate.
	Common Faults	The user can select a group of failures, warnings, and events that when triggered will cause a digital output to turn on. The user also needs to select this feature in the digital outputs menu for one of the outputs.
	Set Dummy Load	This contains the logic to turn on and off a digital output to place an additional load on a generator. The user can select the switch-on and switch-off current thresholds.

Table 8 – Submenus of the Advanced Menu		
J1939 Setup	Manufacturer	John Deere, Volvo, Cummins, Yanmar, Detroit Diesel, Others
	Loss of ECM	Enable, Disable
	Display Group 1	Enable, Disable
	Display Group 2	Enable, Disable
	DTC Display	Disable, Enable
	Active DTC Log	Disable, Enable
	Read Stored DTC	Disable, Enable
	Auto Power ECM	Disable, Enable
	ECM Power Delay	5-30 seconds
	Cummins Idle	Disable, GCP Enable, GC1 Enable
High Engine Tmp	Input Pin	Disable, Analog 2-7
	Signal Source	J1939, Switch input, Sender 1, 2, or 3
	Bypass Delay	0-60 Seconds
	Switch Setting	GND = Fail, Open = Fail
	Shorted Sender	Disable, Warning, Shutdown
	Open Sender	Disable, Warning, Shutdown
	Units	Fahrenheit, Celsius
	Warning Level	10-265°F, 10-265°C
	Failure Level	10-265°F, 10-265°C
Oil Pressure	Input Pin	Reserve, Analog 2-7
	Signal Source	J1939, Switch input, Sender 1, 2 or 3
	Bypass Delay	0-60 Seconds
	Switch Setting	GND = Fail, Open = Fail
	Shorted Sender	Disable, Warning, Shutdown
	Open Sender	Disable, Warning, Shutdown
	Units	PSI, KPa
	Warning Level	0-90 PSI, 0-90 KPa
	Failure Level	0-90 PSI, 0-90 KPa
Fuel Level	Input Pin	Reserve, Analog 2-7
	Signal Source	Switch input, Sender
	Bypass Delay	0-60 Seconds
	Switch Setting	GND = Warning, OPEN = Warning, GND = Fail, Open = Fail
	Shorted Sender	Disable, Warning, Shutdown
	Open Sender	Disable, Warning, Shutdown
	Units	Percentage
	Warning Level	0-90%
	Failure Level	0-90%
	0% Fuel Level	0-1000 Ohms (data sheet or measured value)
	25% Fuel Level	0-1000 Ohms (data sheet or measured value)
	50% Fuel Level	0-1000 Ohms (data sheet or measured value)
	75% Fuel Level	0-1000 Ohms (data sheet or measured value)
	100% Fuel Level	0-1000 Ohms (data sheet or measured

		value)
Oil Level	Input Pin	Reserve, Analog 2-7
	Signal Source	J1939, Switch input, Sender
	Bypass Delay	0-60 Seconds
	Switch Setting	GND = Fail, Open = Fail
	Shorted Sender	Disable, Warning, Shutdown
	Open Sender	Disable, Warning, Shutdown
	Units	Percentage
	Warning Level	0-100%
	Failure Level	0-100%
Fuel In Basin	Input Pin	Reserve, Analog 2-7
	Signal Source	J1939, Switch input, Sender
	Bypass Delay	10-60 Seconds
	Switch Setting	GND = Fail, Open = Fail
	Shorted Sender	Disable, Warning, Shutdown
	Open Sender	Disable, Warning, Shutdown
	Units	Percentage
	Warning Level	0-90%
	Failure Level	0-90%
Low Engine Tmp	Input Pin	Reserve, Analog 2-7
	Signal Source	J1939, Switch input, Sender
	Bypass Delay	10-60 Seconds
	Switch Setting	GND = Fail, Open = Fail
	Shorted Sender	Disable, Warning, Shutdown
	Open Sender	Disable, Warning, Shutdown
	Units	Fahrenheit, Celsius
	Warning Level	10-265°F, 10-265°C
Speed Sensing	Signal Source	J1939, Mag pickup, Gen output
	Rated Freq	10-9990 Hz
	Rated RPM	200-4000 RPM
	Over RPM Warn	100-5000 RPM
	Over RPM Fail	100-5000 RPM
	Under RPM Warn	100-5000 RPM
	Under RPM Fail	100-5000 RPM
AC Frequency	DisconnectFreq	1-100 Hz
	Over Freq Warn	1-100 Hz
	Over Freq Fail	1-100 Hz
	UnderFreq Warn	1-100 Hz
	UnderFreq Fail	1-100 Hz
A/C Voltage	Voltage Source	Disable, Enable
	Voltage Display	Line-Line, Line-Neutral, Both
	Voltage Group	1-Single, 2-Three, 3-Hi Wye, 4-Three phase
	Group 1 Setting	3 Wire Single, 2 Wire Single
	Group 4 Setting	Four Wire Delta, Three Phase
	Over Volt Warn 1	0-700 VAC
	Over Volt Fail 1	0-700 VAC
	Under Volt Warn 1	0-700 VAC
	Under Volt Fail 1	0-700 VAC

	Over Volt Warn 2	0-700 VAC
	Over Volt Fail 2	0-700 VAC
	Under Volt Warn 2	0-700 VAC
	Under Volt Fail 2	0-700 VAC
	Over Volt Warn 3	0-700 VAC
	Over Volt Fail 3	0-700 VAC
	Under Volt Warn 3	0-700 VAC
	Under Volt Fail 3	0-700 VAC
	Over Volt Warn 4	0-700 VAC
	Over Volt Fail 4	0-700 VAC
	Under Volt Warn 4	0-700 VAC
	Under Volt Fail 4	0-700 VAC
A/C Current	Current source	Disable, Enable
	Turns Ratio	5-5000A:5A
	Over Current Warn 1	0-6500 A
	Over Current Fail 1	0-6500 A
	Over Current Warn 2	0-6500 A
	Over Current Fail 2	0-6500 A
	Over Current Warn 3	0-6500 A
	Over Current Fail 3	0-6500 A
	Over Current Warn 4	0-6500 A
	Over Current Fail 4	0-6500 A
	Hi Wye Current	100%, 50%
	Cur Warn Latch	Disable, Enable
Engine Logic	Delay to Start	0-60 seconds
	Glowplug Time	0-60 seconds
	Crank Time	3-60 seconds
	MidHeat Time	0-60 seconds
	Crank Rest Time	1-60 seconds
	Crank Attempts	1-60
	Fuel Crank Rest	Disable, Enable
	False Restart	Disable, Enable
	Post-Heat Time	0-60 seconds
	ETS On Duration	0-30 seconds
	Warm-up Time	0-600 seconds
	RPM Disconnect	100-2000 RPM
	Cool Down Delay	0-600 seconds
	Crank Oil pres	0-90 Psi
Digital Output Setup All selections apply to each individual output	Extra Relay Output A Output B Output C Output D Output E Output F Output G Output H	Disable, Warm-Up, ETS, Glowplug, Cooldown, Over Crank , High Temp Fail , High Temp warn, Low Oil Fail , Low Oil Warning, Under RPM Fail, Under RPM Warn, Over RPM Fail Over RPM Warn, Low Fuel Fail Low Fuel Warn, Battery Fail, Battery Warn, Low Coolant Fail, Low Coolant warn, Not in Auto, Failure, Crank Rest, Engine Running, Crank On,

		Exerciser Alarm, Recharge Alarm Under Volt Warn, Over volt warn, Over Amp Warn, Fuel in Basin, Volt Regulator, Low Temp Warn. Back Light, Auxiliary Warn, Maintenance, System Ready, Common Output 1, Common Output 2, Dummy Loads, High Fuel Warn, Current Latch, Config Warn 1, Config Warn 2, Config Fail 1, Config Fail 2.
Exerciser setup	Exerciser Enable Run Duration Pre-Alarm Delay Repeat Freq. Start Hour Start Date	Disable, enable 10-240 minutes 1-20 minutes 1-672 hours 0-23 1-31
Digital Input Setup	Input A (Bat) Input B (Bat) Input C (Bat) Input D (Bat) Input E (Gnd) Input F (Gnd) Input G (Gnd) Input H (Gnd)	Disable, Low Air Pres Low Hyd Pres, Low Oil Pres, EPS Supply Load Alarm Silence, Low Coolant, Volt Select 1, Volt Select 2, Idle Mode, Start/Stop, Auxiliary Fail, Auxiliary Warn, Charger Fault1, Charger Fault2, High Fuel Warn, Config Warn 1, Config Warn 2, Config Fail 1, Config Fail 2 (located at bottom of menu) Global Trig, Crank Trig, Run Trig, Crank+Run Trig,
Battery Setup	Low Auto Charge Charge Pre-Alarm Charge Duration Recharge Level Low Warn Level Low Fail Level High Warn Level High Fail Level Low Vol InCrank	Disable, Enable 1-60 minutes 10-240 minutes 7-24 volts 7-24 volts 7-24 volts 12-32 volts 12-32 volts 4 – 18 volts
Set Password (Four Digits Long)	Password No. 1 (Digit 1) Password No. 2 (Digit 2) Password No. 3 (Digit 3) Password No. 4 (Digit 4)	0-9 0-9 0-9 0-9
Set Maintain	Reset Counter Enable Counter Count Interval	No, Yes Disable, Enable 10 to 1000 Hours in 10 hour increments.
Set Modbus	Device Address Baud Rate	1 - 247 9600, 19200, 38400, 57600

Common Faults	Failure Table 1 Warning Table 1 Events Table 1 Failure Table 2 Warning Table 2 Events Table 2	**Failures:** Disable, Over Crank, Locked Rotor, HighEngineTemp, LowOil Pressure, Over Speed, Low Fuel Level, Oil Level, Low Coolant, Low Air Pres, Low Hydraulic, Auxiliary Fail, Low Battery, High Battery, UnderSpeed, Under Voltage, Over Voltage, Over Current, Loss of ECM, EPS Load Fail, Config Fail 1, Config Fail 2 **Warnings:** Disable, HighEngineTemp, LowOil Pressure, Over Speed, Low Fuel Level, Oil Level, Fuel In Basin, Auxiliary Warn, Charger Fault, Low Battery, High Battery, Under Speed, Under Voltage, Over Voltage, Over Current, LowEngine Temp, High Fuel Level, Config Warn 1, Config Warn 2 **Events:** Disalbe, EPS Load On, Idle Running, Service Needed, Not In Auto, LoBatt InCrank
Set Dummy Load	Load Check Bypass Delay Load On Point Load Off Point	Disable, Enable 10 – 120s 0 – 500A 0 – 500A

6.1 J1939 Setup

The GSC400 will work with any generator as long as it supports the standard messages listed in the SAE J1939 specification. Standard messages include oil pressure, engine temperature, and engine speed. Some engine control modules have proprietary messages that are intended for specialized devices and are not displayed by the GSC400.

To use J1939 go to the Signal Source submenu for each parameter (see table below) and select J1939. For example to use J1939 to display Oil Pressure you would go to the Advanced Menu, go to "Oil Pressure", go to Signal Source, and then select the J1939 option.

Table 9 – GSC400 Engine Parameters

Engine Parameter	Advanced Menu – Signal Source Location
High Engine Temperature	High Engine Tmp
Oil Pressure	Oil Pressure
Fuel Level	Fuel Level
Oil Level	Oil Level
Fuel In Basin	Fuel In Basin
Low Engine Temperature	Low Engine Tmp
Negative engine temperatures, can be displayed on the GSC400 but any reading below 0^0C (32^0F) is set to 0^0C for warning and failure level detection purposes (e.g. low engine temperature).	

The GSC400 can display extra parameters for the engines listed in the **Manufacturer** submenu. No warnings or failures can be generated with this data. To enable these messages, go to the Display Group 1 and Display Group 2 submenus located in the J1939 menu. If you have a different ECM manufacturer than listed under the Manufacturer menu, the Display Groups 1 and 2 setting does not apply. Table 10 lists the data parameters enabled for each group.

Table 10 – J1939 Addition Parameter Display Options.

Engine Manufacturer	Display Group 1	Display Group 2
John Deere	Engine Torque (%) Friction Torque (%) Load (%)	Intake Temperature (^{0}C) Fuel Temperature (^{0}C) Fuel Rate (L/min)
Volvo Penta	Engine Torque (%) Friction Torque (%) Load (%)	Boost Pressure (kPa) Oil Temperature (^{0}C) Fuel Rate (L/min)
Cummins	Set Speed (RPM) ECM Battery (V) Load (%)	Barometric Pressure (kPa) Fuel Temperature (^{0}C) Oil Temperature (^{0}C)

	Fuel Rate (L/min.)	
Yanmar	Set Speed (RPM) ECM Battery (V) Load (%) Fuel Rate (L/min.)	Barometric Pressure (kPa) Fuel Temperature (^{0}C) Oil Temperature (^{0}C)
Detroit Diesel	Engine Torque (%) Friction Torque (%) Load (%)	Boost Pressure (kPa) Oil Temperature (^{0}C) Fuel Rate (L/min)
Others - Select this is your engine is not listed above.	No Display	No Display

There is also a Loss of ECM submenu in the J1939 menu that you should enable if using J1939. **When enabled, the controller will shut down on a failure when certain J1939 messages have not been received on the CAN bus for 6 seconds.**

Also, when there has been no data received for a specific parameter, that parameter will display "N/A" in place of the value. This will disappear once data for the parameter is received from the bus. This will also occur on startup until the GSC400 accesses the data from the bus. Note that loss of ECM may not be triggered since other parameters may be receiving data from the bus.

Some Engine Control Modules (ECMs) require significant time to power up and initialize before they are ready to control the engine. The GSC400 can be programmed to leave the fuel relay output on while in the AUTO mode by enabling **Auto Power ECM**. This will ensure the ECM is already powered up and read to go when the user desires to start the generator. When the controller enters the Auto Mode the **ECM Power Delay** setting controls the amount of time the GSC400 delays before turning on the fuel output. This is useful to prevent the generator from starting up unexpectedly if it hasn't fully shut down when the controller entered the Auto Mode.

6.1.1 Cummins Idle Speed

The GSC400 can switch between idle and normal operating speed on Cummins generators. When the fuel relay is on, the GSC400 continually sends out a speed command every 250ms to tell the generator which of the two speeds to run at. A digital output must be set to **Idle Mode** (see Table 14 on page 62) and when this digital input is active the generator runs at idle speed; otherwise it runs at normal operating speed.

To enable this feature set **Cummins Idle** to GCP Enable or GC1 Enable. GC1 is the newest protocol while for older engines you will need to use GCP.

If you are powering the ECM externally you may get an error message (if Cummings Idle Speed and Diagnostic Trouble Codes – see below – are enabled), "J1939 Erratic". The

ECM expects the speed update to be sent continuously and if it is not the ECM thinks there is a problem with the J1939 communications.

6.1.2 Diagnostic Trouble Codes (DTCs)

The GSC400 has a DTC feature that when enabled allows the controller to receive currently active DTCs (DM1) messages and display then on the screen as well as optionally store then to the Event Log. The controller can also receive previously active (DM2) messages and display them on user command. DM2 messages are intended for technician troubleshooting and are not stored to the Event Log.

The GSC400 supports the following J1939 standards when reading **DM1** messages:

1. Single package frame J1939-71
2. Multi-packages frame J1939-21
    a. BAM
    b. TP.DP

The GSC400 supports the following J1939 standards when reading **DM2** messages:

1. DM2single package frame J1939-71
2. Multi-package frame J1939-21
    a. BAM
    b. RTS/CTS
    c. TP.DP

The user can enable/disable the DTC feature and configure its behavior with the following settings.

DTC DISPLAY – This setting enables or disables active fault messages (DM1) monitoring. When the DTC DISPLAY feature is enabled the GSC400 can receive active faults in the RUNNING, OFF and AUTO modes on the J1939 bus. Any new received active faults will trigger a message "NEW ACTIVE DTC" and the user can read the message on the GSC400 front panel display. This new message will also be stored into the controller's event log if this feature was enabled.

ACTIVE LOG DTC - The setting enables/disables the storing of active faults (DM1) in GSC400 Event Log. The Event Log reserves 30 storage locations for DM1 messages.

READ STORED DTC – The setting enables/disables the ability to request stored fault codes from the ECM (DM2). When this setting is enabled the GSC400 will allow manually triggered requests of stored faults from the ECM's memory (DM2).

6.2 Analog Inputs

The GSC400 has support for the following analog input types:

1. High Engine Temperature[1]
2. Oil Pressure
3. Fuel Level
4. Oil Level
5. Fuel In Basin
6. Low Engine Temperature[2]

For each of the analog input types, you can select the pin (2 to 7) for the type of analog sender that is connected to it. See Figure 4 on page 9 for the pin locations of the analog input connector. If you are not using one of the inputs indicated then select Disabled. Also, you must select a pin even if you are using J1939 instead of a physical sensor. Two different analog types cannot share the same pin with the exception of the Low Engine Temperature and High Engine Temperature as this allows the user to use one sender to measure both low engine temperature and high engine temperature.

Input Pin Disable Note

When the Input Pin is set to disabled it is actually set to a virtual input where the voltage read is 5V, the source is set to a switch, and the switch setting is set to "Closed = Fail". This effectively disables the input. If changing the source, ensure that the Input Pin is not set to disabled.

In addition, you must select the **Input Type**, such as sender, J1939, or switch (see the section below for more information on senders). If using the switch setting you must determine if the switch is of the normally open or normally closed type. If it is normally open then you would select the "Switch Closed = Failure" otherwise you would select the "Switch Open = Failure". **The factory default sender tables loaded in the GSC400 only support pins 3 and 4.** If you need to use other pins, you must use the GSC400 PC Interface Sender Utility. Refer to the PC Interface manual on more information about the utility. See the next section below.

If the Input Type is set to a switch in the Run Mode (see section 5.3 on page 21) the controller will display "SW" in place of the value that would be displayed if it was set to J1939 or Sender.

A **Bypass Time** can be selected for each input. After crank success, the bypass period will start, and during this period the controller will not enable the warning or failure

[1] Negative engine temperatures, can be displayed on the GSC400 but any reading below 0^0C (32^0F) is set to 0^0C for warning and failure level detection purposes (e.g. low engine temperature, high engine temperature).
[2] Same as (1) above.

checks for this input. After the bypass period, if there are any warnings or failures they will be triggered. The controller will display a message and sound the alarm in the case of a warning or will shut down and sound the alarm in the case of a failure.

Each of the sender types support **Warnings** and/or **Failures**. In the case of high engine temperature, if the data from the sender (or J1939) exceeds the value set, then the controller will give a warning or failure. For the other analog input types, the data from the source must drop below the warning and/or failure setting. Warnings and failure thresholds are only supported when using senders or J1939. **The Low Oil Level and Fuel In Basin warnings are global meaning they are always active even in the OFF state. The warnings for these also ignore the Bypass Time.**

If you have the **Input Type** as a sender then you also need to set the **Open Sender Detection** or **Shorted Sender Detection** to Warning, Failure, or Disable. The Open Sender Detection will trigger if the analog input voltage rises above 4.76V. The Shorted Sender Detection will trigger if the voltage drops below 0.122V.

6.2.1 Fuel Level Sender – Special Case

You will need to know the resistance of the sender at 0%, 25%, 75%, and 100% fuel levels. The resistance values must be either monotonically increasing (e.g. 1, 2, 3, 4, 5) or monotonically decreasing (e.g. 5, 4, 3, 2, 1).

If you have an electronic sender that outputs a voltage between 0 and 5V you can use it on the GSC400. You must convert the voltage output to a corresponding resistance so you can enter it in the menu. To do this, use the following formula:

Resistance = (Voltage Output x Pull-up Resistance) / (5 – Voltage Output)

Where:
Voltage Output – the voltage read at the output of the fuel sender
Pull-up Resistance – in Ohms and depends on the analog input. It is 1000 Ohms for pins 2, 3, and 4; and 5110 Ohms for pins 4, 6, and 7. Only pins 2 and 6 will give the full range of the sender. It is recommended to use pin 6.

In the Fuel Level menu (located in the Advanced Setup menu) you will also need to set the controller type or hardware version (LS/LX, or LSB/LXB). The controller hardware version can be found on the back label contained in the product number (under the bar code). Section 3 on page 9 explains how to read the product number.

6.2.2 GSC400 Sender Support

In the **Signal Source** submenu in each of the six analog input menus there is a selection of three preloaded sender tables from which to choose in addition to the “J1939 Input” and “Switch Input” choices. The sender tables that are preloaded into the controller are given in Table 11. The PC Interface Sender Utility name for versions 1.8.1 and above are

shown for reference and to provide more information to allow the user to determine which sender to use. Refer to the PC Interface manual.

Table 11 – Default Sender Tables

		Position 1	Position 2	Position 3
High Engine Temperature / Low Engine Temperature	**Front Panel Menu Name**	**Datcon 1**	**VDO 2**	**Murphy 1**
	Sender Utility Name	Datcon 330F 491Ohm	VDO 266F 488Ohm	Murphy 368F 488Ohm
	Resistance Type	Low	Low	Low
	Supported Analog Input Pins*	3, 4	3, 4	3, 4
Oil Pressure	**Front Panel Menu Name**	**Datcon 1**	**VDO 1**	**Murphy 1**
	Sender Utility Name	Datcon 99PSI 241Ohm	VDO 99PSI 136Ohm	Murphy 99PSI 237Ohm
	Resistance Type	Low	Low	Low
	Supported Analog Input Pins*	3, 4	3, 4	3, 4

* Revision B controllers. Revision A controllers pin 2 can also be used.

The six analog input pins are divided into two groups: those that support low resistance senders and those that support high resistance senders. Low resistance senders have a maximum resistance of less or equal to 500 Ohms. High resistance senders have a maximum resistance of greater than 500 Ohms (usually they are a few kOhm).

Note that the senders listed in Table 11 cannot be used on all outputs (for the reasons given in the previous paragraph). Table 11 also lists what sender tables may be loaded on each input. If your sender is not supported or you wish to use a sender on an unsupported input then you have to use the sender table configuration utility built into the PC Interface that allows you to create new sender tables or to modify supported ones for the input you desire. Refer to the PC Interface manual for more information.

6.3 Speed Sensing

The speed sensing menu allows you to select the source to use for sensing the rotational speed of the engine. There are three options to choose from:

1. **J1939 Input** – If the engine/generator comes equipped with an engine control module (ECM) that supports the J1939 protocol then the GSC400 can obtain the engine speed from the ECM.

2. **Magnetic Pickup** – If the engine/generator is equipped with a magnetic pickup sensor then the sensor can be connected to the SPEED 1 and SPEED 2 spade terminals on the GSC400.

3. **Generator Output** – The GSC400 can also determine the engine speed indirectly from the generator frequency. The voltage source of the generator must be connected to the SPEED 1 and SPEED 2 terminals.

Over-speed warnings and failures as well as under-speed warnings and failures can be set from the menu in terms of RPM. The warnings and failures apply to all three options above.

6.3.1 Rated Speed

For the magnetic pickup and generator output options you must select the rated frequency and rated speed. The GSC400 uses these values together to calculate the engine speed from the magnetic input or generator output.

The **rated speed** is the speed (in revolutions per minute, RPM) the engine runs at when producing power. For example some generators run at 1800RPM while others run at 3600RPM.

The **rated frequency** is usually either 50Hz or 60Hz. It is the frequency of the generator output when producing power. For a magnetic input the rated frequency is determined by the number of teeth on the flywheel and is calculated by:

Rated frequency = (Number of teeth x Rated Speed) / 60

For the generator output option the rated frequency is normally the frequency of the generator: 50Hz or 60Hz.

6.4 Generator (AC Voltage / Current / Frequency) Setup

The AC Frequency, AC Voltage, and AC Current menus allow the measurement and display of the AC voltage, current, and frequency from the generator.

6.4.1 AC Frequency

In the AC Frequency menu, warnings and failures can be triggered for frequencies under and/or over settable thresholds. The **DisconnectFreq** setting is used by the GSC400 controller as a backup to the speed input. If the speed input is not detected, the controller checks the **DisconnectFreq** settings. If the measured frequency is greater than this setting then the engine will be considered running.

6.4.2 AC Voltage

The user can enter under voltage, over voltage, and over current settings for four different voltage configurations. This allows the GSC400 to be used on multiple generator types without having to configure each GSC400 or it allows a single generator to support multiple voltage configurations without having to go into the menu system. Each voltage group supports a different generator configuration:

1. Voltage Group 1 – Single Phase (two or three wire)
2. Voltage Group 2 – Three Phase (Delta or Hi Wye)
3. Voltage Group 3 – Three Phase Hi Wye (Hi Wye centre tapped)
4. Voltage Group 4 – Three Phase (three or four wire delta)

Voltage Group 1 has an option (the **Group 1 Setting** under the AC Voltage menu) for two wire (Hot and Neutral) or three wire (A, B, Neutral) single phase. If two wire single phase is selected the GSC400 display is fixed to L-N.

Voltage Group 2 can be used for 3 wire delta and non-center-tapped Hi Wye configurations. **Voltage Group 3** is the same as Voltage Group 2. There is a **Group 3 Setting** that can be enabled and is normally used for center tapped Hi Wye applications where the voltage displayed on the controller is double the actual measured voltage. Voltage Group 3 with the Group 3 Setting enabled is also useful in non-center-tapped Hi Wye and 4-wire Delta applications where the user wishes to measure a voltage greater than 600VAC – the maximum voltage the GSC400 supports. In this case the user can use a 2:1 potential transformer (PT) to step down the voltage to the GSC400 and still have the GSC400 display the correct voltage.

Voltage Group 4 has an option (the **Group 4 Setting** submenu under the AC Voltage menu) for four wire delta or three phases (default). The two different configurations are shown in Figure 8. The three wire delta requires three voltage transformers to create the neutral reference.

The GSC400 controller requires a neutral reference. All voltages are measured line to neutral and then converted for display as line to line if required unless Voltage Group 1 is selected with the two wire option in which case only Line to Neutral is displayed.

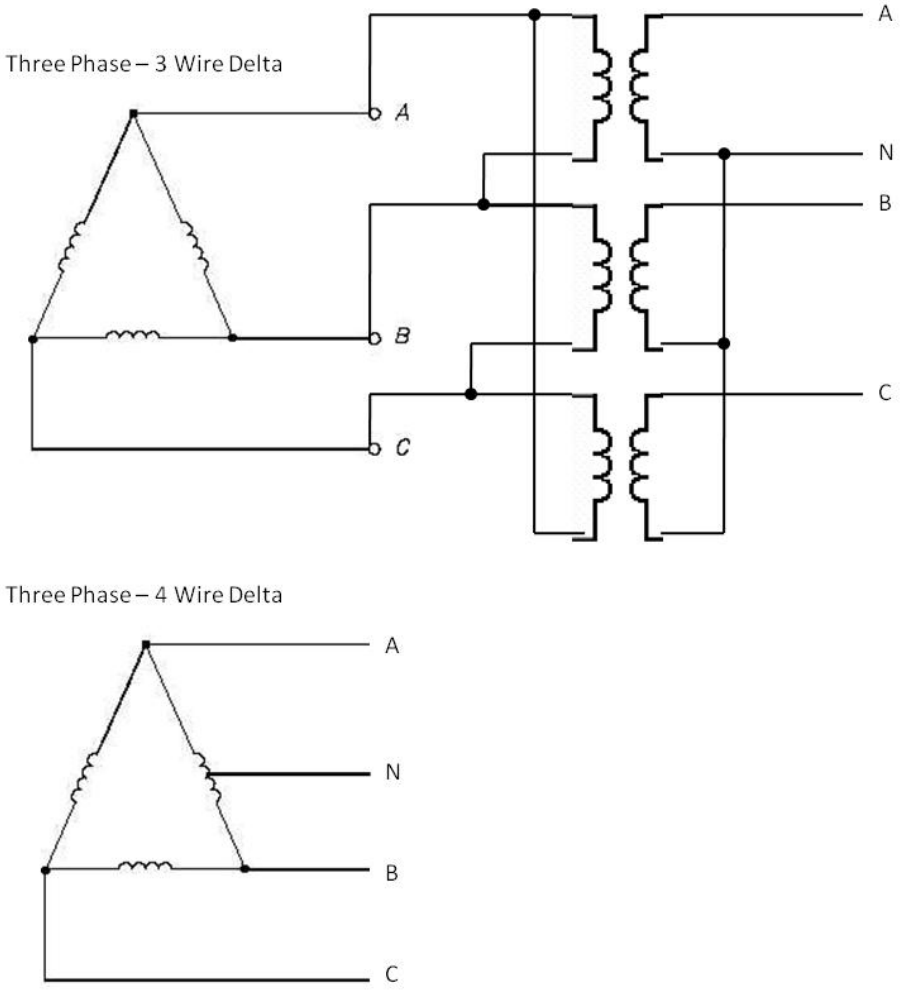


Figure 8 – Three-wire versus four wire delta generator configurations

6.4.2.1 Voltage Select Inputs

It is possible to automatically choose between each configuration by setting one or two of the digital inputs to **Volt Select 1** and **Volt Select 2**. This allows the GSC400 to automatically re-configure its voltage display as well as warning/shutdown trip points relating to AC voltages and currents. This is useful for mobile generators where the voltage selections can be selected via a CAM switch.

Warning: The Voltage Select Inputs override the **Voltage Group** submenu parameter in the AC Voltage menu.

Table 12 Voltage Select Inputs

	Voltage Configuration	Digital Inputs	
		Volt Select 1	Volt Select 2
Voltage Group 1 (Single Phase)	1 Phase, 3-wire (2-wire option also selectable)	Open Circuit	Open Circuit
Voltage Group 2	3 Phase, 4-wire Wye	ACTIVE[τ]	Open Circuit
Voltage Group 3	3 Phase, 4-wire (2x display voltage option also selectable)	Open Circuit	ACTIVE[τ]
Voltage Group 4	3 Phase, 4-wire Wye (4-wire Delta option also selectable)	ACTIVE[τ]	ACTIVE[τ]

[τ] If Digital Input Pin A, B, C or D is used, then ACTIVE is defined as a switched to +BAT connection. If Digital Input Pin E, F, G or H is used, then ACTIVE is defined as a switched to GND connection.

NOTE: If only a single AC Group Sel function is selected, then the remaining unassigned AC Group Sel is equivalent to an "Open Circuit" in the above table.

6.4.3 AC Current

The GSC400 controller is designed to measure AC current from the generator with the use of current transformers (CTs). The maximum current on the AC current terminals of the GSC400 is limited to 5A.

The "**Turns Ratio**" sub menu is used to setup the CT ratio. All numbers in this menu are in terms of 5A. For example select 1000 means 1000:5A which, in turn, means the GSC400 displays 1000A on the screen when the current measured on the GSC400 AC Current terminals is 5A. **The GSC400 current terminals can handle a maximum of 5A. Larger currents can damage the GSC400.**

The AC Current menu is also used to set the over current warnings and shutdowns. These are grouped in terms of the voltage group 1 to 4. The current warning and failure depends on the voltage group selected in the Voltage Group submenu of the AC Voltage menu.

The **Hi Wye Current** parameter (second to last entry in the AC Current menu) is used to double the current reading (50% selection). If this is not desired then the 100% selection should be selected. Some generators have two wires for each phase, and as such, the current transformer (which is placed on one lead) will see only 50% of the current from each phase.

The **Cur Warn Latch** option (last entry in the AC Current menu) is used to latch on a special digital output (see Current Latch in Table 13 on page 59) that turns on when the current exceeds the Current Warning Threshold and can only be turned off by the user

from the front panel. On a current latch condition the LCD displays “Over Current Latched.” and “<Up Arrow> + <Down Arrow> for Unlatch”.

The current transformers (CTs) negative leads must be terminated individually into the GSC400 AC Current connector. **Do not tie the negative leads together to a common neutral.** See the system wiring diagram (Figure 4 on page 15) for more details.

6.4.4 AC Current and Voltage Calibration

Each GSC400 undergoes an advanced two point calibration at the factory and typically does not required calibration except in the following instances:

1. Current Transformers (CT) are used that have poor tolerances.
2. The uncommon occurrence where the AC signal from the generator is distorted with a high total harmonic distortion (THD).

DynaGen has a software utility that can perform a basic calibration of the current and voltage.

6.5 Engine Logic

The Engine Logic menu contains the settings that control the starting and stopping of the engine. All parameters in bold below are located in the engine logic menu unless otherwise noted.

The **Crank Disconnect** setting determines the speed that must be attained before the crank output is turned off and the engine is considered to be running.

The **Crank Oil Pressure** parameter is used to determine when to check for the **Locked Rotor** condition. If the oil pressure is lower than the Crank Oil Pressure the GSC400 will check the engine speed for a locked rotor condition (see section 6.5.1.1 on Locked Rotor).

6.5.1 Startup Sequence

All parameters in bold below are located in the engine logic menu unless otherwise noted.

When performing an automatic or manual start, the controller will wait for the **Delay To Start** duration and then turn on the glow plug output for the **Preheat** duration.

After the preheat time, the crank output is turned on for the duration specified by the **Crank Time**. The fuel output is also turned on. If the engine speed does not go above the **Crank Disconnect Setting** before the crank time then the crank output is turned off and the controller waits a period specified by the **Crank Rest Time**. The locked rotor condition is also checked while cranking (see *6.5.1.1 Locked Rotor* below). The fuel output is also turned off unless the “**Fuel On During Crank Reset**” is enabled.

THE LCD WILL TURN OFF DURING THE FIRST 2 SECONDS OF CRANKING TO LIMIT THE VOLTAGE DIP DURING CRANKING.

If the **Midheat** Time is greater than zero, the glow plug output remains on during cranking but not during crank rest. The glow plug output turns off if a crank failure occurs, once crank success is reached (unless the PostHeat is set to a value greater than 0s), or if the Midheat time expires.

After the crank rest delay expires, the controller turns on the fuel and crank outputs and attempts to start the generator again. This is repeated until the number of tries equals the **Crank Attempts**. If the controller cannot start the generator after the set number of crank attempts, the failure state is entered and an **over crank failure** is displayed on the screen.

If the generator starts successfully and the "**Restart on False Start**" submenu is set to Enabled then the engine speed is monitored for 10 seconds. If the Off key is pressed during these 10 seconds the engine will go into OFF mode without cooling down (if cool down is enabled). If the engine speed goes below the crank disconnect speed the controller attempts to restart the engine/generator. At the same time, if the **Warm-up** sub menu is set to a value greater than zero, an output is turned on (one of the digital outputs or Extra relay must be set to "Warm Up" and the input is active low). This is used to disengage any load or potential loads until the gen-set is warmed up. Once the Warm-up time has expired the output is turned off (input goes high).

Once the controller enters the Running state and if the **PostHeat** time is greater than 0, the glow plug output is turned on for the duration of the PostHeat time.

6.5.1.1Locked Rotor

The GSC400 has a safety feature where a locked rotor condition will be detected. This applies to generators only. To disable this feature set the **Crank Oil Pressure** in the engine logic menu to 0.

During cranking the locked rotor condition is checked if the oil pressure is above the **Crank Oil Pressure** parameter (engine logic menu). The engine speed and AC frequency are checked and if both are 0 the crank time is shortened to 3s (including the time passed in cranking). If the engine/generator has not reached the crank disconnect speed at the end of the 3s the GSC400 will stop cranking and go into a Locked Rotor Failure.

6.5.2 Shutdown Sequence

When the OFF key is pressed while the engine/generator is running and if the **Cool-Down** submenu is set to a value greater than 0 seconds the generator will go into Cool

Down mode where an output is turned on (one of the digital outputs must be set to Cool Down). Once the Cool Down time is expired, the fuel relay is turned off and the controller enters the OFF state. If the **ETS On Duration** is set to a value greater than 0 seconds an output will be turned on for the time set (one of the digital outputs must be set to "Energize-to-Stop") by the ETS On Duration submenu.

6.6 Digital Output Setup

There are eight 200mA digital outputs (all switched to ground) and one 40A digital output (dry contact), the Extra output, all of which are configurable. Each feature (listed in Table 13 below) is permitted to be set to only one digital output.

Table 13 – Digital Output Selections

Name	Description
Warm Up	This sets up the output to be controlled by the Warm-up feature. See **section 6.5.1** for more details. The Warm-up time is set in the engine logic menu. This is an active low output (i.e. the output remains off during warm-up and turns on after warm-up is finished). The output always remains off when the controller is not in the RUN mode.
Energize to Stop (ETS)	This allows the Energize to Stop feature to control an output. The time duration is set in the engine logic menu. See **section 6.5.2** for more details.
Preheat	This allows the Preheat, Midheat, and Postheat features in the engine logic menu to control the output. The Preheat time is set in the engine logic menu. See **section 6.5.1** for more details.
Cool Down	This allows the Cool Down feature to control the output. The Cool Down duration is set in the engine logic menu. See **section 6.5.2** for more details.
Over Crank	This turns on the digital output when the Over Crank Failure is activated. See **section 6.5.1** for more details. The number of crank attempts is set in the engine logic menu.
High Temp Failure	This turns on the digital output if the High Engine Temperature Failure is activated. See **section 6.2** for more details.
High Temp Warning	This turns on the digital output if the High Engine Temperature Warning is activated. See **section 6.2** for more details.
Low Oil Failure	This turns on the digital output if the Low Oil Pressure Failure is active. See **section 6.2** or **section 6.8** for more details.
Low Oil Warning	This turns on the digital output if the Low Oil Pressure Warning is activated. See **section 6.2** for more details.
Under Speed Failure	This turns on the digital output if the Under Speed Failure is activated. See **section 6.3** for more details.
Under Speed Warning	This turns on the digital output if the Under Speed Warning is activated. See **section 6.3** for more details.
Over Speed Failure	This turns on the digital output if the Over Speed Failure is activated. See **section 6.3** for more details.
Over Speed Warning	This turns on the digital output if the Over Speed Warning is activated. See **section 6.3** for more details.

Low Fuel Failure	This turns on the digital output if the Low Fuel Failure is activated. See **section 6.2** for more details.
Low Fuel Warning	This turns on the digital output if the Low Fuel Warning is activated. See **section 6.2** for more details.
Battery Failure	This turns on the digital output if the Low or High Battery Failure is activated. See **section 6.9** for more details.
Battery Warning	This turns on the digital output if the Low or High Battery Warning is activated. See **section 6.9** for more details.
Low Coolant Failure	This turns on the digital output if the Low Coolant Failure is activated. This is controlled by the Low Coolant Digital Input described in Table 14 in **section 6.8**.
Low Coolant Warning	Reserved for future use. Selecting this feature will have no effect.
Not In Auto	This turns on the digital output when the controller is not in the Auto state. **Section 5.3** describes the various states of the controller.
General Failure	This turns on the digital output when any failure is active.
Crank Rest	This turns on the digital output when the controller is in the crank rest state after a crank attempt. The crank rest duration is set in the engine logic menu. See **section 6.5.1** for more details.
Engine Running	This turns on the digital output when the controller enters the run state (crank success). The run state is described in **section 5.3**.
Engine Cranking	This turns on the digital output when the crank output is on. See **section 6.5.1** for more details.
Exerciser Alarm	This turns on the digital output when the engine/generator starts on an exerciser event (**section 6.7**).
Battery Recharge Alarm	This turns on the digital output when the engine/generator starts on a low battery event (**section 6.2**).
Under Voltage Warning	This turns on the digital output when the AC Under Voltage Warning (**section 7.4**) is activated.
Over Voltage Warning	This turns on the digital output when the AC Over Voltage Warning (**section 7.4**) is activated.
Over Current Warning	This turns on the digital output when the AC Over Current Warning (**section 7.4**) is activated.
Fuel In Basin Warning	This turns on the digital output if the Low Fuel In Basin Warning (**section 6.2**) is activated.
Voltage Regulator	This allows the digital output to be controlled by the idle feature. The idle feature also requires a digital input to be set to Idle Mode (see **section 6.8**). See section 5.5 on page 24 for more information on the Idle Mode feature.
Low Temperature Warning	This turns on the digital output if the Low Engine Temperature Warning (**section 6.2**) is activated.
Backlight	This turns off the digital output if the LCD backlighting turns off. The controller enters the sleep mode (**section 5.3**) when this occurs.
Auxiliary Warning	This turns on the output if the Auxiliary Warning Digital Input (see Table 14 in **section 6.8**) is active.
Maintenance Timer	This turns on the output if maintenance is required to be performed on the engine/generator. See **section 6.11**.
System Ready	This turns on the output if the controller is in the auto state with no

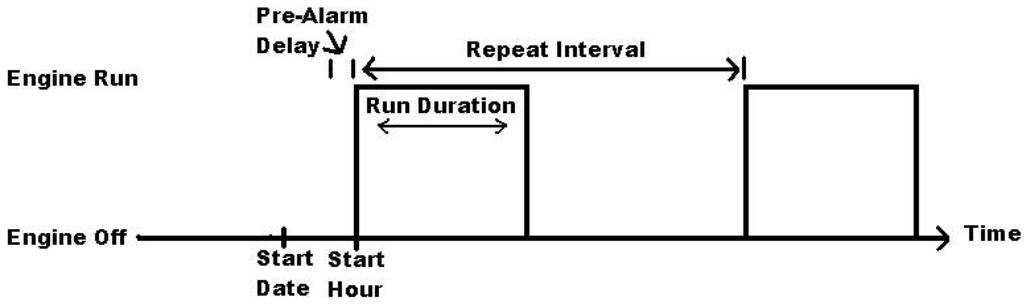
	warnings (some warnings are ignored for this feature).
Common Fault Output 1	This turns on the output if the Common Fault 1 feature is active. See **section 6.13** for more details.
Common Fault Output 2	This turns on the output if the Common Fault 2 feature is active. See **section 6.13** for more details.
Dummy Load	This allows the digital output to be controlled by the Dummy Load feature. See **section 6.14** for more details.
High Fuel Level Warning	This turns on the output if the High Fuel Level Warning digital input in Table 14 on page 62 is active.
Current Latch	This turns on the output if the Cur Warn Latch in the AC Current menu (see Table 8 on page 42) is set to Enable and the High Current Warning is active. The output can only be turned off by the user. See section 6.4.3 on page 56 for more information.
Config Warn 1	This turns on the output if the Config Warn 1 digital input (Table 14 on page 62) is active.
Config Warn 2	This turns on the output if the Config Warn 2 digital input (Table 14 on page 62) is active.
Config Fail 1	This turns on the output if the Config Fail 1 digital input (Table 14 on page 62) is active.
Config Fail 2	This turns on the output if the Config Fail 2 digital input (Table 14 on page 62) is active.

6.7 Exerciser Setup

The GSC400 can be set to automatically start the engine/generator at regular intervals if left in the AUTO state. This is controlled by the Exerciser Setup menu. The **Exerciser Enable** should be set to Enabled if this feature is desired.

The GSC400 will display a message and sound the buzzer for a set amount of time (**Pre-Alarm Delay**) to alert nearby personnel that the generator is about to start. The engine/generator will run for a set period of time (**Run Duration**) and then shut down.

The **Start Date** and **Start Hour** determine the date (0 to 31) and time when the engine/generator will first start. After the first exerciser start, the engine/generator will start up on regular intervals given by the **Repeat Freq** which is measured in hours.



The exerciser feature depends on the GSC400 internal clock. Make sure the clock is set to the proper time and date.

GSC400 internal clock information can remain "in memory" for approximately 2 weeks when no DC power is supplied to the controller. Two week memory storage is available in a completely charged controller clock. DC power is required to be supplied continually to the GSC400 for approximately 1 hour to allow a complete clock charge.

6.8 Digital Input Setup

There are eight digital inputs. Each input can be selected to any of the features given in Table 14 below.

Table 14 – Digital Input Selections

Name	Description
Low Air Pressure	This input generates a Low Air Pressure failure when active only in Crank. It is ignored in the OFF, AUTO, and RUN modes.
Low Hydraulic Pressure	This input generates a Low Hydraulic Pressure failure when active only in Crank. It is ignored in the OFF, AUTO, and RUN modes.
Low Oil Pressure	This input generates a "Low Oil Pressure" failure when active only when the controller is in the RUN mode.
EPS Supplying Load	If the generator is starting up but is not running (i.e. the controller is not in the RUN Mode) and if the input is active, the GSC400 will cancel the start sequence and enter the failure state on an EPS load failure. After crank success, if the input is active, the "EPS Supplying Load" lamp on the GSC400 front face will turn on.
Alarm Silence	This input silences the buzzer on the GSC400 unit when active.
Low Coolant [Level]	This input generates a Low Coolant Level failure when active.
Volt Select 1	These inputs allow the user to change the supported generator configuration without having to go into the controller menu. See **section 6.4.2.1** for more details.
Volt Select 2	

Idle Mode	This input, when active, allows the generator to run at a lower speed without triggering under-voltage, under-frequency, or under-speed warnings or failures. "Idle Running" is displayed on the GSC400 display when this input is active. See section 5.5 on page 24 for more information on the Idle Mode feature. The idle mode can also turn on a digital output (see the Voltage Regulator digital output feature in **Table 13 on page 59**). This output is usually used to turn off the generator voltage regulator when idle mode is entered but can be used for any purpose. This is also used for Cummins J1939 Idle Feature. See section 5.12.1 on page 35 for more information.
Start / Stop	When the digital input is active the generator is started if in the Auto mode. If the digital input becomes inactive this places the controller back into the Auto mode (shuts down the generator). This performs the same function as the remote start contacts.
Auxiliary Failure	An Auxiliary Failure is generated when the input is active. This can occur in the Off, Auto, Cranking, and Running states.
Auxiliary Warning	An Auxiliary Warning is generated when the input is active. This can occur in the Off, Auto, Cranking, and Running states.
Charger 1 Fault	A Charger 1 Fault warning is generated when the input is active.
Charger 2 Fault	A Charger 2 Fault warning is generated when the input is active.
High Fuel Level Warning	A "High Fuel Level Warning" is generated when the input is active.
Config Warn 1 Config Warn 2 Config Fail 1 Config Fail 2	These inputs when active generate a warning/failure and a configurable text message is displayed to the screen when the input is active. The text message can only be configured from the GSC400 PC Interface. The length of the message is limited to 15 characters. The user can control the states in which these features are enabled. The selections are: 1. **Global** –Everywhere 2. **Crank** – From start of delay-to-start to the end of cranking 3. **Run** – RUN Mode only 4. **Crank+Run** – Combination of 2 and 3 above. These settings are located at the bottom of the menu for each input.

6.9 Battery Setup

The Battery menu allows the user to set the low and high battery **warning** and **failure** levels. In addition, the generator can be made to automatically start when in the AUTO state if the voltage drops below the **Recharge Level**.

The controller will display Low Voltage During Cranking on the screen if during cranking the voltage drops below the **Low Vol InCrank** setting.

Note: When the generator is running, the battery voltage will equal the alternator charging voltage. The actual open-circuit battery voltage may be lower than displayed.

6.9.1 Low Battery Recharge

The GSC400 can be setup to automatically run the generator if the battery voltage goes below a certain point, the **Recharge Level** setting. The **Charge Enable** parameter must be set to Enable to enable the low battery recharge feature. The **ChargeDuration** setting controls the length of time the generator will run before shutting down.

Note that the GSC400 does not have the capability of charging the battery to a specified voltage level.

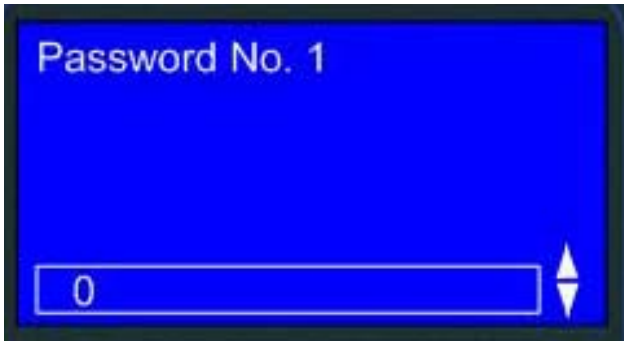
6.10 Password Setup

The GSC400 allows a 4 digit password to be entered to protect the advanced setup menu from any unauthorized changes. This password will be needed to perform any changes to the advanced setup. If the password is entered incorrectly, the controller will allow 3 more tries before the GSC400 returns back to the main menu.

To set each digit of the password, do the following:

- Select Password No.1 (Digit 1) Enter the desired number 0-9
- Select Password No.2 (Digit 2) Enter the desired number 0-9
- Select Password No.3 (Digit 3) Enter the desired number 0-9
- Select Password No.4 (Digit 4) Enter the desired number 0-9

Remember to write down the password for future reference. **The default password is all zeros.**



You can only reset the password using the GSC400 PC Interface. To reset the passwords click on "Load Factory Defaults" under File in the top menu. **This will reset ALL settings to their factory default so make sure to record the controller settings before doing this.**

6.11 Set Maintain

This menu controls the service feature that is used to alert the user of required generator maintenance and can be enabled or disabled from this menu. If enabled, the **count interval** menu allows the user to set the number of hours until next service. The number of hours to next service is displayed in the Basic Setup menu under Maintenance (see Table 5 on page 29).

Once the count interval reaches 0 hours it displays a service message, records an event in the Event History Log, and continues to count down, displaying negative hours in the Maintenance submenu, until it is reset by the technician. The **reset counter** submenu is used by the technician to reset the counter after service is performed. The service feature does not count down to the next service until it is reset in this menu.

6.12 Set Modbus

The GSC400 acts as a slave on a Modbus RS-485 network and can – on request by the master device – remotely transmit warning, failure, and event indications. The device address and baud rate can be set from this menu.

See Appendix B: Modbus Map for more communication interface details.

6.13 Common Faults

Common Fault 1 and **Common Fault 2** menus contain tables of all the events, warnings, and failures available in the GSC400 controller and allows the user to select those to generate a trigger when active. The trigger can be used to turn on a digital output, store the status of the trigger (active / inactive) to the Modbus Common Fault registers, or both. Both the common fault 1 and common fault 2 menus generate their own independent trigger and use separate modbus registers and digital outputs.

A digital output must be set to **Common Fault Output 1** if using the Common Fault 1 menu or **Common Fault Output 2** if using the Common Fault Output 2 menu to allow the trigger to turn on the digital output (see section 6.6 Digital Output Setup).

Using the PC Interface, the user can also mask the event, warning, and failure tables for each of the common faults. For example the user can set the Common Fault 1 modbus register to respond to events, warnings, and failures and set the Common Fault 1 digital output to respond to failures only. This configuration is not available in the front panel menu system; the PC Interface must be used.

6.14 Set Dummy Load

The dummy load feature allows the user to turn on an output if the AC current is below a settable threshold (**Load On Point**). This is useful for applications where the generator must have a minimal load to prevent damage to the generator.

Upon crank success (RUN Mode entered), if enabled, the feature waits for a configurable bypass time, then starts to monitor the AC current. If the AC current remains above the Load On Point for 6.5 seconds then the dummy load digital output is turned on. If the AC current rises and remains above a settable threshold (**Load Off Point**) for 1.5s, the dummy load digital output is turned off.

A digital output must be set to dummy load to use this feature.

7 Recommended Maintenance

The actions in Table 15 should be performed routinely.

WARNING: When performing any GSC400 or Engine maintenance be certain controller is in OFF Mode, is isolated from all possible sources of power, and the Crank wire is removed from the Controller.

Table 15 – Recommended Maintenance

Procedure	Action
Making the controller safe for inspection and maintenance.	Disconnect all possible power sources before controller inspection.
Inspect controller mounting location for possible safety issues	Inspect mounting location for any safety or fire issues. Inspect for dirt, wiring damage and mechanical damages.
Inspect controller for loose fasteners, terminals and wiring connections.	Check all hardware including controller wiring, terminals etc. for any looseness due to vibrations etc.
Clean area around controller	Periodically inspect and remove any debris/dirt from within or near the controller.
Check for any overheating due to loose connections	Check for any discoloration, melting or blistering of any wiring or connections
Perform regular testing of controller	Perform regular testing of the controller to check for proper operation.

8 Default Configuration Settings

GSC400's are factory programmed and shipped with default settings loaded into the controller.

Table 16 – GSC400 Default Settings

FUNCTION	DEFAULT SETTINGS	
J1939	Manufacturer	John Deere
	Display Group 1	Disable
	Display Group 2	Disable
	DTC Display	Disable
	Active DTC Log	Disable
	Read Stored DTC	Disable
	Auto Power ECM	Disable
	ECM Power Delay	6 seconds
	Cummins Idle	Disable
	Conversion Method	Conversion 2
High Engine Temp	Input Pin	Input Pin 2
	Signal Source	Switch
	Bypass Delay	30 Seconds
	Switch Setting	SW Closed = Fail
	Shorted Sender	Disable
	Open Sender	Disable
	Units	Fahrenheit
	Warning Level	200°F
	Failure Level	220°F
Oil Pressure	Input Pin	Disable
	Signal Source	Switch
	Bypass Delay	30 Seconds
	Switch Setting	SW Closed = Fail
	Shorted Sender	Disable
	Open Sender	Disable
	Units	PSI
	Warning Level	20 PSI
	Failure Level	15 PSI
Fuel Level	Input Pin	Disabled
	Signal Source	Switch
	Bypass Delay	30 Seconds
	Switch Setting	SW Closed = Fail
	Shorted Sender	Disable
	Open Sender	Disable
	Units	Percentage
	Warning Level	25%
	Failure Level	5%
Oil Level	Input Pin	Disable
	Signal Source	Switch
	Bypass Delay	10 Seconds
	Switch Setting	SW Closed = Fail

	Shorted Sender	Disable
	Open Sender	Disable
	Units	Percentage
	Warning Level	10%
	Failure Level	5%
Fuel In Basin	Input Pin	Disable
	Signal Source	Switch
	Bypass Delay	11 Seconds
	Switch Setting	SW Closed = Fail
	Shorted Sender	Disable
	Open Sender	Disable
	Units	Percentage
	Warning Level	2%
	Failure Level	5%
Low Engine Temperature	Input Pin	Disable
	Signal Source	Switch
	Bypass Delay	10 Seconds
	Switch Setting	SW Closed = Fail
	Shorted Sender	Disable
	Open Sender	Disable
	Units	Fahrenheit
	Warning Level	10ºF
Spd Sensing	Signal Source	Generator Output
	Rated Freq	60 Hz
	Rated RPM	1800 RPM
	Over Speed Warn	1950 RPM
	Over Speed Fail	2050 RPM
	Under Speed Warn	1650 RPM
	Under Speed Fail	1550 RPM
AC Frequency	Frequency Disconnect	22 Hz
	Over Freq Warn	70 Hz
	Over Freq Fail	75 Hz
	Under Freq Warn	50 Hz
	Under Freq Fail	45 Hz
A/C Voltage	Voltage Source	Enable
	Voltage Display	Line-Neutral
	Voltage Group	Group #1 (Single)
	Over Volt Warn 1	250 VAC
	Over Volt Fail 1	260 VAC
	Under Volt Warn 1	230 VAC
	Under Volt Fail 1	220 VAC
	Over Volt Warn 2	220 VAC
	Over Volt Fail 2	230 VAC
	Under Volt Warn 2	195 VAC
	Under Volt Fail 2	185 VAC
	Over Volt Warn 3	500 VAC
	Over Volt Fail 3	520 VAC
	Under Volt Warn 3	460 VAC
	Under Volt Fail 3	440 VAC
	Over Volt Warn 4	630 VAC

	Over Volt Fail 4	650 VAC
	Under Volt Warn 4	570 VAC
	Under Volt Fail 4	550 VAC
A/C Current	Current source	Enable
	Turns Ratio	100A:5A
	Over Current Warn 1	90 A
	Over Current Fail 1	100 A
	Over Current Warn 2	80 A
	Over Current Fail 2	90 A
	Over Current Warn 3	20 A
	Over Current Fail 3	25 A
	Over Current Warn 4	15 A
	Over Current Fail 4	20 A
Engine Logic	Delay to Start	0 seconds
	Pre-heat Time	0 seconds
	Crank Time	15 seconds
	MidHeat Time	0 seconds
	Crank Rest Time	15 seconds
	Crank Attempts	3
	Fuel Crank Rest	Enable
	False Restart	Enable
	Post-Heat Time	0 seconds
	ETS On Duration	0 seconds
	Warm-up Time	600 seconds
	Crank Disconnect	650 RPM
	Cool Down Delay	0 seconds
	Crank Oil pres	10 PSI
Digital Output Setup All selections apply to each individual output	Extra Relay	Disable,
	Output 1	Disable
	Output 2	Disable
	Output 3	Disable
	Output 4	Disable
	Output 5	Disable
	Output 6	Disable
	Output 7	Disable
	Output 8	Disable
Exerciser setup	Exerciser Enable	Disable
	Run Duration	30 minutes
	Pre-Alarm Delay	5 minutes
	Repeat Frequency	336 hours (14 days)
	Start Hour	12
	Start Date	8
Digital Input Setup All selections apply to each individual input	Input 1 (Bat)	Disable
	Input 2 (Bat)	Disable
	Input 3 (Bat)	Disable
	Input 4 (Bat)	Disable
	Input 5 (Gnd)	Disable
	Input 6 (Gnd)	Disable
	Input 7 (Gnd)	Disable

	Input 8 (Gnd)	Disable
Battery Setup	Low Auto Charge	Disable
	Charge Pre-Alarm	1 minute
	Charge Duration	91 minutes
	Recharge Level	10.4 volts
	Low Warn Level	11.2 volts
	Low Fail Level	7 volts
	High Warn Level	15 volts
	High Fail Level	16 volts
	Low Vot InCrank	8
Set Password	Password No. 1	0
	Password No. 2	0
	Password No. 3	0
	Password No. 4	0

9 Appendix A: Accessory List

9.1 GSC400 Controller Harness - Accessories

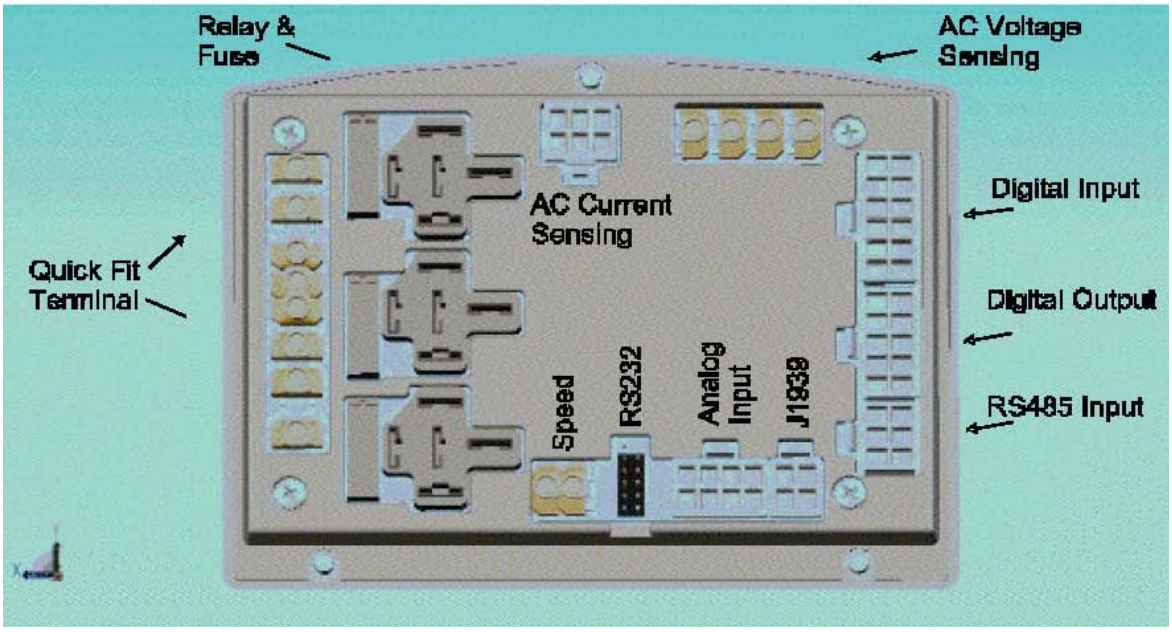


Figure 9 – GSC400 terminal names and layout. View from rear of controller.

Table 17 – GSC400 Harness Part Numbers

Harness Name	5ft Harness	Circuit Numbers (Pins) Populated
CAN (J1939) (Rev 3)	1373R3-5	1, 2, 3[1]
AC Current Sensing (Rev 2)	1375R2-5	All circuits
Digital Outputs (Rev 2)	1377R2-5	1, 2, 3, 4
Analog Inputs (Rev 2)	1376R2-5	1, 2, 3, 4
Digital Inputs (Rev 2)	1378R2-5	4, 7, 8, 9*, 10, 11, 12*

[1] The new Rev 3 of this harness contains a terminating resistor. If the GSC400 is not the last device on the network this resistor can be cut out.
*Circuits 9 and 12 are tied together. This disables the emergency stop input. For users who desire this feature cut this wire.

The following table identifies all the wiring harnesses as part of the GSC400 controller:

Table 18 – GSC400 Wiring Harness Part List

Harness Description	Stock Code	Harness Length	Circuit Numbers (Pins) Populated[2]
AC Current Sensing*	DWG1375R2-5	5 Feet	1, 2, 3
Digital Input*	DWG1378R2-5	5 Feet	All circuits
Analog Input*	DWG1376R2-5	5 Feet	1, 2, 3, 4
J1939	DWG1373R3-5	5 Feet	1, 2, 3, 4
Digital Output	DWG1377R2-5	5 Feet	4, 7, 8, 9[1], 10, 11, 12[1]
Modbus	Call DynaGen	Call DynaGen	Call DynaGen

*The AC Current Sensing, Digital Input and Analog Input Harness can be purchased together as a starter kit: **Stock Code ACC0086**.

[1] Circuits 9 and 12 are tied together. This disables the emergency stop input. For users who desire this feature cut this wire.

[2] See Figure 4 on page 15 for information on pin numbers.

9.2 GSC400 Programmer Assembly

Table 19 – GSC400 Programmer Part List

Programmer Description	Stock Code
USB/Serial Programmer	GSC400-PGMRB

9.3 CT's (Current Transformers)

Current transformers are required for display of AC current. One CT is required for each phase to be displayed. The wiring for CT's is as follows:

In single phase applications:

- Phase A to terminals Phase A*
- Phase B to terminals Phase B*

In three phase applications:

- Phase A to terminals Phase A*
- Phase B to terminals Phase B*
- Phase C to terminals Phase C*

In center tap delta applications:

- Phase A to terminals Phase A*
- Phase B to terminals Phase B*
- Phase C to terminals Phase C*

* White wire assumed positive. Black wire assumed negative.

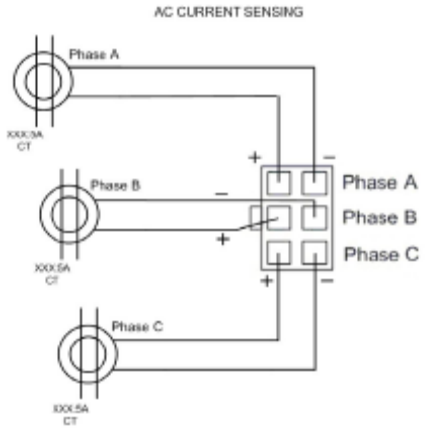


Figure 10 – AC current sensing connections.

Table 20 – Current Transformers Part List

CT Description	Stock Code	Manufacturer's Part No.
100A:5A	ACC0045	PC&S-546-100-L
200A:5A	ACC0046	PC&S-546-200-L
300A:5A	ACC0047	PC&S-546-300-L
500A:5A	ACC0048	PC&S-546-500-L
600A:5A	ACC0049	PC&S-546-600-L
1000A:5A	ACC0050	PC&S-546-1000-L
1500A:5A	ACC0057	PC&S-546-1500-L

9.4 Engine Sending Units

Senders are required if display of display of engine sensors are required. Connections would be installed as follows.

Table 21 – Senders Part List

Sender Description	Stock Code	Part # Description
Datcon – Oil Pressure (34 to 241 Ohms)	ACC0074	Datcon 102225-00 1/8” = 27 NPTF (Heavy duty version of Datcon 2505-00)
Datcon – Temperature (7 to 491 Ohms)	ACC0027	Datcon 02022-00 1/8”-27 NPTF

9.5 GSC400 replaceable 12/24VDC relays

The GSC400 controller is designed to operate in either 12 or 24 VDC battery start systems. When operating in 12VDC systems the fuel, crank and extra relays need to be rated 12VDC coil. When operating in 24VDC systems these relays need to be rated 24VDC coil. To maintain the UL rating, the HASCO relays must be used.

Table 22 – Relay Part List

Relay Description	Stock Code	Manufacturer’s Part No.
12VDC AZETTLER	RLY0029	AZ-973-1C-12DC
24VDC AZETTLER	RLY0043	AZ-973-1C-24DC
12VDC HASCO	RLY0053	CAR-1A-40-DC12S
24VDC HASCO	RLY0054	CAR-1A-40-DC24S

9.6 GSC400 Fusing

Output relays are protected by onboard 40A fuse protection. Smaller amperage fuses from many automotive stores may be used in place of the higher current 40A. If installing lower amperage fuse protection be certain that current draw does not exceed the fuse current limit.

Table 23 – GSC400 fuse part list.

Fuse Description	Stock Code	Part # Description
40A, 32VDC Auto Fast Action	FUS0012	Littlefuse-257040

10 Appendix B: Modbus Map

Modbus communications uses master-slave communication in which only the master can initiate a transaction, called a query. The slave addressed by the query will respond by either supplying the requested data to the master or by performing the requested action. A slave device never initiates communications, and will always generate a response to the query unless certain error conditions occur. The GSC400 is designed to communicate on the Modbus only as a slave device.

A master can query slaves individually or query all slaves collectively by initiating a broadcast message. A slave does not send a response message to a broadcast query. If a query requests actions unable to be performed by the slave, the slave response message will contain an Exception Response Code defining the error detected. Query and response messages share the same message structure. Each message is comprised of four message fields: the Device Address, the Function Code, the Data Block, and the Error Check field.

Query / Response Message Structure:
* Device Address
* Function Code
* Eight-Bit Data Bytes
* Error Check

Device Address Field
The Device Address field contains the unique Modbus address of the slave being queried. The addressed slave will repeat its address in the Device Address field of the response message. This field is 1 byte.

Function Code Field
The Function Code field in the Query message defines the action to be taken by the addressed slave. This field is echoed in the Response message, and will be altered by setting the MSB of the field to "1" if the response is an error response. This field is 1 byte.

Data Block Field
The query Data block contains additional information needed by the slave to perform the requested function. The response Data block contains data collected by the slave for the queried function. An error response will substitute an Exception Response Code for the Data Block. The length of this field varies with each query.

Error Check Field
The Error Check field provides a method for the slave to validate the integrity of the query message contents and allows the master to confirm the validity of response message contents. This field is 2 bytes.

Serial Transmission Details
A standard Modbus network offers 2 transmission modes for communication: ASCII or RTU. The GSC400 supports only the RTU (Remote Terminal Unit) mode. Each 8-bit byte in a message contains two 4-bit hexadecimal characters. The message is transmitted in a continuous stream with the LSB of each byte of data transmitted first. Transmission of each 8-bit data byte occurs with 1 start bit and 1 stop bit. Parity checking is none. The transmission baud rate is user-configurable, and both baud rate and Modbus address can be altered during menu operation. If altered, the new baud rate and / or address will not be seen until the after power is recycled on the GSC400. The GSC400 supported baud rates are 9600, 19200, 38400, and 57600.

Firmware versions 1.38 to 1.46 support 1st generation Modbus registers. Firmware version 1.50 and above supports both 1st generation as well as 2nd generation registers. For new applications it is recommended to utilize 2nd generation modbus registers.

10.1 Modbus Commands

GSC400 supports two Modbus commands "0x03 Read Holding Register (4x)" and "0x06 Write Single Register"

To make the communication work, user need to setup something in GSC400 setting to corresponding with the RSA unit. In the GSC400 Advanced menu, there is a menu "SET Modbus", user can setup the GSC400 device address and device baud rate there.

To use the 0x03 command to read the holding register, the user will need to set the holding register start address, quantity of bytes to read, and the scan rate. When sending the start address, use the following formula: **start address = register address – 40 000**.

1. Obtain the correct holding register address from the register map below

2. The GSC400 device only supports reading up to 20 registers at a time; reading more than 20 registers at a time will give an illegal address error. Also be careful to not read invalid registers as the GSC400 register map is not continuous.

3. The recommended scan rate is 1000ms. The GSC400 updates holding register address from 40050 to 40244 every 1 second.

4. All registers that are written too, and all modbus registers in the range of 1 to 10, are updated every 250ms.

As an example, a user wanting to read the engine speed and other related parameters (the engine speed holding address is 0x40150), would use the 0x03 command with start address 0x40150 and quantity 20, and a scan rate of 1000ms. The user's device will continue polling address 0x40150 to 0x40169 at 1000ms duration.

Note: There are only two addresses that support the 0x06 command, the address are 0x40098 and 0x40130.

10.2 Register Map

NOTE: All parameters are assumed to be unsigned integer values unless otherwise specified in the "Range" column.

Table 24 – Modbus Register Map

Register	Parameter	Range	Read / Write	Data format	Units
1st Generation ModBus Support **(For new applications utilize 2nd generation support)**					
Warning and fault shutdown are updated by controller once every 250ms.					
40001	Highest Severity Event (Read only)	bit 16 = Alarm State, bit 15-14 = Severity, Bits 13-10 = Reserved, Bits 9-1 = Event #			
40002	Previous Highest Severity Event (R)	bit 16 = Alarm State, bit 15-14 = Severity, Bits 13-1 = Event #			
40003 ~ 40010 (Read Only)		Each event uses 5bits, b4, b3, b2, b1, b0 where b0 is the least significant bit. b0 = The event status (warning or shutdown occurring) 0 = Not Active, 1 = Active b2-b1 = The severity of the event 0 = Take No Action, 1 = Warning/Acknowledge 2 = Action Required, 3 = Take Immediate Action (shutdown) b3 = Alarm Action (indicates if GSC400 is sounding buzzer) 0 = No Audible Alarm, 1 = Sound Audible Alarm b4 = Warning/Failure Feature Enabled/Disabled 0 = Disabled, 1 = Enabled			
40003	Events number 1 System Ready bit 4-0 Events number 2 Over crank bit 9-5 Events number 3 High Engine Temperature Warning / Shutdown bit 14-10				
40004	Events number 4 Low Oil Pressure Warning / Shutdown bit 4-0 Events number 5 Over speed bit 9-5 Events number 6 Emergency Stop bit 14-10				
40005	Events number 7 Low Coolant Level bit 4-0 Events number 8 Low Coolant Temperature bit 9-5 Events number 9 Low Fuel Level In Tank bit 14-10				

40006	Events number 10 Low Fuel Pressure bit 4-0 Events number 11 Emergency Power Supplying Load bit 9-5 Events number 12 Generator Running bit 14-10			
40007	Events number 13 Generator Not In Auto Mode bit 4-0 Events number 14 Battery Charger Fault bit 9-5 Events number 15 Battery Voltage Low bit 14-10			
40008	Events number 16 Battery Voltage High bit 4-0 Events number 17 Low Battery Voltage During Cranking bit 9-5 Events number 18 Locked Rotor bit 14-10			
40009	Events number 19 Common Fault #1 Warning/Shutdown bit 4-0 Events number 20 Common Fault #2 Warning/Shutdown bit 9-5 Events number 21 Reserved bit 14-10			
40010	Reserved			
2nd generation Modbus register support **Basic Modbus Functions**				
1. CONTROLLER INFORMATION (Read Only)				
40080	GSC400 Front Panel LED Status	0 = OFF, 1 = ON	R	bit0: Over Crank Failure (red) bit1: Over Crank Warning (amber) bit2: High engine temp. failure (red) bit3: High engine temp. warning (amber) bit4 : Low oil pressure failure (red) bit5: Low oil pressure warning (amber) bit6: Engine over speed failure (red) bit7 : Engine over speed warning (amber) bit8 : Low fuel level failure (red) bit9 : Low fuel level warning (amber) bit10: Low Battery warning (amber) bit11: Battery Ok (solid green in OFF and RUN modes, flashing green in AUTO mode) bit12: Not in auto (red) bit13: Not used bit14: Low coolant level shutdown (red) bit15: Low coolant level warning (amber)

40081				bit0: EPS supplying load shutdown (red) bit1: EPS supplying load (green) bit2: not used bit3 : Glow plug on (green) bit4 : Failure is active (Red Failure LED) bit5 to bit7: (not used) bit8: Crank relay On (no LED) bit9: Fuel relay ON (no LED) bit10: Extra relay ON (no LED) bit11 to bit13: (Reserved) bit14 and bit 15: (not used)
40082	Events / Warnings Status	0 = OFF, 1 = ON	R	bit0 : Warm up finished bit1 : ETS is on bit2 : Glow plug is on bit3 : Cool Down is active bit4 : Over crank occurred bit5 : High engine temperature failure bit6 : High engine temperature warning bit7 : Low oil pressure failure bit8 : Low oil pressure warning bit9 : Under speed failure bit10: Under speed warning bit11: Over speed failure bit12: Over speed warning bit13: Low fuel level failure bit14: Low fuel level warning bit15: Battery low and high level failure
40083				bit0: Battery low and high level warning bit1: Not used bit2: Low coolant level failure bit3 : Controller is not in auto bit4: Failure has occurred bit5 : Cranking rest active bit6: Controller is in RUN mode (after crank success) bit7: Controller is cranking bit8: Exerciser pre-alarm active (this bit will flash) bit9: Battery charging pre-alarm is active (this bit will flash) bit10: AC under voltage warning

				bit11: AC over voltage warning bit12: AC over current warning bit13: Fuel in basin warning bit14: Voltage Regulator Digital Output feature is on. bit15: Low engine temperature warning
40084				bit0: Backlight is on bit1: Auxiliary warning bit2 : Maintenance is required bit3: System is OK (definition: no warning, including not in auto warning) bit4: Common fault 1 digital output feature bit5: Common fault 2 digital output feature bit6: Dummy load digital output feature bit7 : High fuel level warning bit8 : Over current latch (AC Current feature) bit9: User configurable warning 1 digital output feature bit10: User configurable warning 2 digital output feature bit11: User configurable failure1 digital output feature bit12: User configurable failure 2 digital output feature bit13 to bit15: (Reserved)
40085				bit0 to bit4: (Reserved) bit5 : Low oil level failure bit6: Low air pressure failure digital input bit7: Low hydraulic failure digital input bit8: Auxiliary input failure bit9: Low battery level failure bit10: High battery level failure bit11: AC over voltage failure bit12: AC under voltage failure bit13: AC over current failure bit14: J1939 Loss of ECM failure bit15: EPS load failure

40090	GSC400 hardware version number	1.00 ~ 9.99	R	Version format is "X.YY" ; Decimal format where X represents a number from 1 – 9 and is stored in the high byte of 40090. YY represents a decimal number from 00 to 99 and is stored in the lower byte of 40090.
40091	GSC400 firmware version number	1.00 ~ 9.99	R	
40092 ~ 40095	GSC400 serial number	4 to 7 characters	R	The serial number is stored in 7 digit decimal format with the high byte of register 40092 containing the high MSB and the low byte of register 40095 containing the LSB. **Unused characters are stored as zeros.** For example serial number 0012450 would be stored as follows: 40092 MSB = 0 40092 LSB = 0 40093 MSB = 1 40093 LSB = 2 40094 MSB = 4 40094 LSB = 5 40095 MSB = 0 40095 LSB = NOT USED
2. START/STOP CONTROL AND COMMAND				
Start/Stop registers are polled by the controller every 250mS.				
40098	SYSTEM DISABLE	0x5DA2 (23970)	W	When 0x5DA2 is written to address 40098 this places the controller in the OFF mode (System disabled). The register is read in all controller operating modes (Running, Auto, Failure, Menu/sleep modes). **CAUTION – when received in the Running mode the controller immediately goes to the OFF mode (no cool-down is performed). When received in failure mode this will reset the system failure and revert to the OFF mode.**
	SYSTEM ENABLE	0x5BA4 (23460)	W	When 0x5BA4 is written to address 40098 this places the controller in the

				AUTO mode (waiting to start). **The register is read only in the OFF mode of operation and ignored in all other operating modes.**
	START	0x9768 (38760)	W	When 0x9768 is written to address 40098 this initiates an automatic start. **This register is only read in the AUTO mode of operation and is ignored in other modes.**
	STOP	0x57A8 (22440)	W	When 0x57A8 is written to address 40098 this initiates a shutdown/stop of the equipment. This register is only monitored when the system is running (start signal received) and is ignored in all other operating modes. **When cool down is enabled and a stop command is received the controller will proceed to the cool down mode then shutdown equipment.**
	REQUEST DM2	0xBB44	W	Send a request to controller for reading the previous DTC codes. If the controller read the previous DTC code success, the data will be updated in the range of 40180 to 40244. This registers can hold maximum 32 DTC code
3. SYSTEM CONTROL STATUS Read Only. Allows user to determine current controller mode (and sub-mode). Any active events or warnings will be displayed up to a maximum of 6.				
40100	System operating mode	0x90 0x93 0x96 0x99 0x9C	R (Read Only)	The possible controller modes are: MENU/OFF SLEEP mode 0x90 (144) OFF mode 0x93 (147) AUTO mode 0x96 (150) FAILURE mode 0x99 (153) RUNNING mode 0x9C (156) **When in controller menu/OFF sleep mode if the controller is required to go to the AUTO mode a system disable command (40098) must be written**

				followed by system enable command (40098).
40101	System Sub-state	0 ~ 40	R	The controller sub-mode (if applicable): 19 DLY TO START 20 PREHEATING 21 CRANKING 22 WARM UP 23 CRANK REST 25 COOLDOWN 26 SHUTDOWN 27 IDLE RUNNING 31 IDLE COOL 32 REMOTE START RUN (RSC contacts) 33 Front Panel Run (Manual Run) 34 MODBUS RUN (modbus start triggered) 35 LOW BATTERY RUNNING 36 EXERCISER RUNNING 0 None of the above. 0 corresponds to none of the above sub modes of operation.
40102 ~ 40107	Active Event message queue	0 ~ 255	R (Read Only)	A maximum of 6 events/warnings are stored concurrently. One event/warning per register. Ensure that controller is not in sleep mode before reading. 0 READING ABORT (DTC reading) 1 Low Voltage In Crank 2 Charger 1 Fault 3 Need Maintenance 4 CRANK FAILURE 5 Charger 2 Fault 6 Custom Warning 1 7 Custom Warning 2 8 CRANK SUCCESS 9 Empty Space 11 REQUESTING DTC 14 LAMP TEST 15 High Fuel Level 16 Warning 17 Low AC Voltage 18 Over Cur Latched

				19 ↑+↓ FOR UNLATCH 20 READ DTC SUCCESS 21 FUEL OFF – If fuel turned off during crank rest. 22 Low Engine RPM 23 High Engine RPM 24 High AC Current 25 High AC Voltage 26 High Engine Temp 27 Low Oil Pressure 28 Low Fuel Level 29 EXERCISE Prealarm 30 CHARGE Prealarm 31 NO DTC AVAILABLE 32 DM2 REQUEST FAIL 33 KEEP FUELING – If fuel remains on during crank rest. 34 Lock Mark symbol (screen locked when in Run Mode) 35 NOT IN AUTO 36 OFF FOR SILENCE 37 OFF FOR ALARM 38 POWER ON ECM... 39 WAITING ECM... 40 NEW ACTIVE DTC 41 DTC PROCESS DOWN 43 FAILURE 45 WAIT TO START 46 Low Oil Level 47 Low Speed Warn 48 Locked Rotor 49 Fuel In Basin 50 Low Battery 51 High Battery 52 AUTO FOR SILENCE 53 AUTO FOR ALARM 54 Low Engine Temperature warning 55 Open Engine Temperature sender 56 Short Engine Temperature sender 57 Open Oil Pressure sender

				58 Short Oil Pressure sender 59 Open Fuel Level sender 60 Short Fuel Level sender 61 Open Oil Level sender 62 Short Oil Level sender 63 Open Fuel Basin sender 64 Short Fuel Basin sender 65 Open Engine Temperature sender 66 Short Engine Temperature sender 70 EMERGENCY STOP 71 Auxiliary Warn 72 Under Frequency warning 73 Over Frequency warning 255 (0xFF) Empty – No message in queue
40108	Active Failure	0 ~ 44	R (Read Only)	If the controller is in an active FAILURE mode the failure number in register 40108 corresponds to the below failure mode. 0 reserved 1 Internal reserved 1 (ADE Read) 2 Internal reserved 2 (KEYBOARD) 3 Internal reserved 3 (ADC read) 4 Internal reserved 4 (RS485) 5 Internal reserved 5 (RS232) 6 Internal reserved 6 (ADE Write) 7 Internal reserved 7 (TLE6230) 8 Internal reserved 8 (EEPROM) 9 (Reserved) 10 HIGH ENGINE TEMP 11 LOW OIL PRESSURE 12 UNDER SPEED 13 OVER SPEED 14 LOW FUEL LEVEL 15 LOW BATTERY 16 LOW COOLANT 17 OVER CRANK 18 OVER VOLTAGE 19 UNDER VOLTAGE 20 OVER CURRENT 21 EPS LOADS ERROR 22 LOW AIR PRESSURE 23 LOW HYDRAULIC

				24 LOW OIL LEVEL 25 LOCKED ROTOR 26 HIGH BATTERY 27 LOSS OF ECM COMMUNICATION 28 OPEN ENG TEMP 29 SHORT ENG TEMP 30 OPEN OIL PRES 31 SHORT OIL PRES 32 OPEN FUEL LEVEL 33 SHORT FUEL LEVEL 34 OPEN OIL LEVEL 35 SHORT OIL LEVEL 36 OPEN FUEL BASIN 37 SHORT FUEL BASIN 38 OPEN ENGINE TEMP 39 SHORT ENGINETEMP 40 AUXILIARY FAIL 41 UNDER FREQUENCY 42 OVER FREQUENCY 162 USER TEXT FAIL 1 163 USER TEXT FAIL 2 255 (0xFF) Empty – No failure message
40109	System Sub-state delay countdown	0 ~ 65535	R	The value of register 40109 corresponds to the count down delay for one of the below mentioned sub-states. To determine which sub-state is in countdown mode read register 40101. Resolution is 1 second. The following sub-states incorporate delay countdown: DLY TO START PREHEATING CRANKING WARMUP CRANK REST COOLDOWN IDLE COOL (COOLDOWN IN IDLE) LOW DC BATTERY CHARGING EXERCISER RUNNING
4. DIGITAL I/O AND ANALOG INPUTS				

(Read Only) Allows the status of the digital inputs and outputs to be read.				
Digital I/O and Analog Input will update every 1 second once.				
40110	Digital Input	0 ~ 1023	R (Read Only)	Status of controller digital inputs. OFF means the input is not active or not connected. Bit0 = Input A (BAT) 0 = OFF, 1 = ACTIVE Bit1 = Input B (BAT) 0 = OFF, 1 = ACTIVE Bit2 = Input C (BAT) 0 = OFF, 1 = ACTIVE Bit3 = Input D (BAT) 0 = OFF, 1 = ACTIVE Bit4 = Input E (GND) 1 = OFF, 0 = ACTIVE Bit5 = Input F (GND) 1 = OFF, 0 = ACTIVE Bit6 = Input G (GND) 1 = OFF, 0 = ACTIVE Bit7 = Input H (GND) 1 = OFF, 0 = ACTIVE Bit8 = Start/Stop 1 = OFF, 0 = ACTIVE Bit9 =Emergency Stop 0 = OFF, 1 = ACTIVE **Note: Do not read the start/stop digital input (Bit 8) as a means to determine if start signal active or not active, please read the register 40100 for system state.**
40111	Digital Output	0~2047	R (Read Only)	Status of controller outputs. 0 corresponds to output OFF or NOT ACTIVE, while a 1 corresponds to output ON or ACTIVE. Bit0 = Output A 0 = OFF, 1 = ACTIVE Bit1 = Output B 0 = OFF, 1 = ACTIVE

				Bit2 = Output C 0 = OFF, 1 = ACTIVE Bit3 = Output D 0 = OFF, 1 = ACTIVE Bit4 = Output E 0 = OFF, 1 = ACTIVE Bit5 = Output F 0 = OFF, 1 = ACTIVE Bit6 = Output G 0 = OFF, 1 = ACTIVE Bit7 = Output H 0 = OFF, 1 = ACTIVE Bit8 = Extra Relay 0 = OFF, 1 = ACTIVE Bit9 = Fuel Relay 0 = OFF, 1 = ACTIVE Bit10 = Crank Relay 0 = OFF, 1 = ACTIVE	
Advanced Modbus register support					
1. ENGINE-GENERATOR PARAMETERS (Read Only)					
Running parameters will update every 1 second. The engine speed, high engine temperature, low engine temperature, oil pressure, and fuel level parameters display 0xFF01 if not available (if source is J1939). The six sender inputs (High Engine Temperature, Low Engine Temperature, Fuel Level, Oil Pressure, Oil Level, and Fuel In Basin) parameters display 0xFF00 if set to switch or disabled.					
40150	Engine Speed	0 ~ 6553.0	R	1 bit equal 0.1 RPM Reading 18000 corresponds to 1800RPM	RPM
40151	High Engine Temperature	0 ~ 250.0	R	1 bit equal 0.1 unit Reading 1000 corresponds to 100.0C	C
40153	Low Engine Temperature	0 ~ 250.0	R	1 bit equal 0.1 unit Reading 1000 corresponds to 100.0C	C
40154	Fuel Level	0.0 ~ 100.0	R	1 bit equal to 0.1% Reading 1000 corresponds to 100.0%	%

40155	Oil Pressure	0.0 ~ 1000.0	R	1 bit equal 0.1 unit Reading 1000 corresponds to 100.0KPa	KPa
40156	Oil Level	0.0 ~ 100.0	R	1 bit equal to 0.1% Reading 1000 corresponds to 100.0%	%
40157	Fuel In Basin	0 ~ 100.0	R	1 bit equal to 0.1% Reading 1000 corresponds to 100.0%	%
40160	Line Voltage A-B	0~999.9	R	1 bit 0.1V Reading 9999 corresponds to 999.9.V	V
40161	Line Voltage B-C		R		V
40162	Line Voltage C-A		R		V
40163	Phase Voltage A		R		V
40164	Phase Voltage B		R		V
40165	Phase Voltage C		R		V
40167	Phase A Current	0~999.9	R	1 bit equal to 0.1A Reading 9999 corresponds to 999.9A	A
40168	Phase B Current		R		A
40169	Phase C Current		R		A
40170	AC frequency	0 ~ 100.0	R	AC frequency Reading 600 corresponds to 60.0Hz	Hz
40174	Battery voltage	0 ~ 31.8	R	1 bit equal 0.1V Reading 318 corresponds to 31.8V	V
40175	PCB Board temperature	-55 ~ 130 Signed Integer 16 bit	R	1 bit 0.1C Reading 1000 corresponds to 100.0C Positive or negative values can be identified by reading the high byte of MSB. A 1 in bit 15 corresponds to a negative number while a 0 corresponds to a positive number	C

40176	Current Run time (Total run time on active running event). NOTE: Timer is reset to Zero after active running event has been terminated (OFF or AUTO mode waiting to start)	0 ~ 6553.5	R	1 bit 0.1 hour 65535 corresponds to 6553.5Hs	Hours
40177 ~ 40178	Engine hours	0~255999.9	R	Total Accumulated running hours, the reading in 40177, 1 bit equal to 0.1 hour. The reading in 40178, 1 bit equal to 1000 hours. So the total hours = **40178** * 1000 + **40177**/10	Hours
40145	Maintenance Time	-1000 ~ +1000 Signed Integer 16 bit	R	The unit is 0.1 hour (1 bit = 0.1 hour); Positive values count down the hours to next maintenance. Negative values count up the hours since maintenance should have been performed. Positive or negative values can be identified by read the high byte of MSB. A 1 in bit 15 corresponds to a negative number while a 0 corresponds to a positive number.	
2. EVENTS HISTORY LOG					
40130	Read Previous Entry	0x6C93 (27795)	W	Write control command to holding register address.	
	Read Next Entry	0x639C (25500)	W		

The controller will check the log request every 1 second. Each time a new command is received, the controller will scroll either down or up one message (until it reaches either the bottom or top of the message log), one message and update the log content in address 40131 to 40141. Once at the top of the log, registers 40131 to 40141 are not changed if a “Read Previous Entry” command is received. Once at the bottom of the log, registers 40131 to 40141 are not changed if a “Read Next Entry” command is received. After 20s of receiving further commands in register 40130, all registers are cleared (i.e. set to 0).

40131	Log Type	Only supports the values listed in format column.	R	1 Internal reserved 1 (ADE Read) 2 Internal reserved 2 (KEYBOARD) 3 Internal reserved 3 (ADC read) 4 Internal reserved 4 (RS485) 5 Internal reserved 5 (RS232) 6 Internal reserved 6 (ADE Write) 7 Internal reserved 7 (TLE6230) 8 Internal reserved 8 (EEPROM) 9 (Reserved). 10 HIGH ENGINE TEMPERATURE 11 LOW OIL PRESSURE 12 UNDER SPEED 13 OVER SPEED 14 LOW FUEL LEVEL 15 LOW BATTERY 16 LOW COOLANT 17 OVER CRANK 18 OVER VOLTAGE 19 UNDER VOLTAGE 20 OVER CURRENT 21 EPS LOADS ERROR 22 LOW AIR PRESSURE 23 LOW HYDRAULIC 24 LOW OIL LEVEL 25 LOCKED ROTOR 26 HIGH BATTERY 27 LOSS OF ECM COMMUNICATION 28 OPEN ENG TEMPERATURE 29 SHORT ENG TEMPERATURE 30 OPEN OIL PRESSURE 31 SHORT OIL PRESSURE 32 OPEN FUEL LEVEL 33 SHORT FUEL LEVEL 34 OPEN OIL LEVEL 35 SHORT OIL LEVEL 36 OPEN FUEL BASIN 37 SHORT FUEL BASIN 38 OPEN ENGINE TEMPERATURE 39 SHORT ENGINE TEMPERATURE 40 AUXILIARY FAIL 41 UNDER FREQUENCY

				42 OVER FREQUENCY 43 HIGH FUEL LEVEL 44 POWER ON 45 AUTO ENABLE 46 OFF ENABLE 47 MANUAL START 48 MANUAL STOP 49 REMOTE START 50 REMOTE STOP 51 EMERGENCY STOP 52 CHARGE START 53 CHARGE OVER 54 MAINTAIN NEEDED 55 INITIALIZING 56 MAINTAINED 57 NEXT EXERCISER 58 RUN EXERCISER 59 EXERCISER OVER 60 CHARGER 1 FAULT 61 CHARGER 2 FAULT 62 LOG CORRUPTED 63 MODBUS START 64 MODBUS STOP 162 (0xA2) CONFIG FAIL 1 163 (0xA3) CONFIG FAIL 2 233 (0xE9) DTC	
40132	Log Time stamp Minutes	Decimal 0 ~ 59	R	Decimal format High 4-bit tens 0 ~ 5 Low 4-bit ones 0 ~ 9	Minute
40133	Log Time stamp Hours	Decimal 0 ~ 23		Decimal format High 4-bit tens 0 ~ 2 Low 4-bit ones 0 ~ 9	Hour
40134	Log Time stamp Date	Decimal 1 ~ 31		Decimal format High 4-bit tens 0 ~ 3 Low 4-bit ones 0 ~ 9	Day
40135	Log Time stamp Month	Decimal 1 ~ 12		Decimal format High 4-bit tens 0 ~ 1 Low 4-bit ones 0 ~ 9	Month

40136	Log DTC code. Only valid if entry contains DTC message (if Log Type register – 40131 equals 233).	0 ~ 255	R	Lowest byte of SPN (bit 8 MSB)
40137		0 ~ 39		Middle byte of SPN (bit 8 MSB)
40138		0 ~ 31		3 highest bits of SPN and the FMI (bit 8 is SPN MSB and bit 5 is FMI MSB)
40139				Bit 8 CM, other 7 bits OC (bit 7 MSB)
40140	Log Sequence	1 ~ 100	R	Current log being read.
40141	Total Log Number	1 ~ 100	R	Total number of entries in the log.
J1939 DIAGNOSTIC TROUBLE CODES Active DTC parameters will be updated and synchronized with front panel GSC400 display. Previously active DTC parameters will remain active even after they are read from the registers. Parameters can only be cleared once power is cycled to GSC400 controller or a shutdown is initiated. (Note: In one byte,Bit7 is MSB,Bit0 is LSB)				
40114	Active DTC lamp status and reserved lamp status	0~65536	R	The High byte of 40114 holding register Bit 7~6 malfunction indicate lamp status Bit 5~4 red stop lamp status Bit 3~2 amber warning lamp status Bit 1~0 protect lamp status Low byte reserved for lamp status
40115	Active DTC No. 1 (Each DTC code will be stored in 2 holding register, High Byte of the first register is Byte 1, Low byte is byte 2, high byte of second register is byte 3, Low Byte is Byte 4). See right column for more information.	0~65536	R	(DTC was defined in SAE J1939-73) **CM**: Bit7 of Byte 4. SPN Conversion Method bit. If CM = 0 below applies, else see below the table. **SPN**: SPN is 19 bits value, the MSB of SPN is spn18, and the LSB of SPN is spn0. Data range is from 0 to 524,287. Bit7~Bit5 of the byte 3 is spn18~spn16, Bit7~Bit0 of the byte 2 is spn15~spn8, and the Bit7~Bit0 of byte 1 is spn7~spn0. **FMI**: FMI is 5 bits value; data range is from 0 to 31. It is the Bit4~Bit0 of byte 3. **OC**: OC is 7 bits value; data range is from 0 to 126. It is the Bit6~Bit0 of the byte 4.
40116		0~65536	R	

40117 ~ 40126	**Registers 40117 to 40126 not shown. They contain Active DTC No. 2 to 6 and are in the same format as above.**			
40180	Previous Active DTC lamp status and reserved lamp status	0~65536	R	Bit 8~7 malfunction indicate lamp status Bit 6~5 red stop lamp status Bit 4~3 amber warning lamp status Bit 2~1 protect lamp status Low byte reserved for lamp status
40181	Previous Active DTC No. 1 (Same format as Active DTC registers above)	0~65536	R	Same format as Active DTC registers above.
40182		0~65536	R	
40183 ~ 40244	**Registers 40183 to 40244 are not shown. They contain Previously Active DTC No. 2 to 32 and are in the same format as above.**			

11 Appendix C: J1939 Old DTC Conversion Methods

This appendix was created to assist the user in decoding the information contained in the modbus DTC (DM1 and DM2) registers if the generator ECM does not support the newest DTC conversion method. The diagnostic trouble codes on J1939 are specified in a specific format. Older J1939 specifications had three conversion methods for the SPN and it was impossible to tell them apart from the DTC data alone. One had to consult the engine manufacturer.

Newer J1939 specifications follow one SPN method (Version 4) and the user can determine if this method applies by looking at the CM bit. It will be set to 1 if Version 4 applies, and set to 0 if Versions 1, 2, or 3 applies. If the CM bit is 0, see below for the three conversion methods. Byte 1 to Byte 4 refers to the individual bytes in the GSC400 DTC Modbus registers. See registers 40115 and 40116 on page 96, above.

DTC Conversion Method (Version) 1:
Byte 1: 8 most significant bits of 16 most significant bits of SPN
Byte 2: 8 least significant bits of 16 most significant bits of SPN
Byte 3: 3 most significant bits of byte contain the 3 least significant bits of SPN
5 least significant bits of byte contain the FMI
Byte 4: most significant bit of byte contains CM
7 least significant bits of byte contains OC

DTC Conversion Method (Version) 2:
Byte 1: 8 least significant bits of 16 most significant bits of SPN
Byte 2: 8 most significant bits of 16 most significant bits of SPN
Byte 3: 3 most significant bits of byte contain the 3 least significant bits of SPN
5 least significant bits of byte contain the FMI
Byte 4: most significant bit of byte contains CM
7 least significant bits of byte contains OC

DTC Conversion Method (Version) 3:
Byte 1: 8 least significant bits of SPN
Byte 2: 8 second byte of SPN
Byte 3: 3 most significant bits of byte contain the 3 most significant bits of SPN
5 least significant bits of byte contain the FMI
Byte 4: most significant bit of byte contains CM
7 least significant bits of byte contains OC

DTC conversion method 3 is the same as DTC conversion method 4 (the new J1939 standard) except that the CM bit is 1 so it is impossible to tell it apart from versions 1 and 2. Version 4 has the bit set to 0 which allows the user to know the conversion format without consulting the engine manufacturer.